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VOLUME XII NOVEMBER 5, 1923 NUMBER 23

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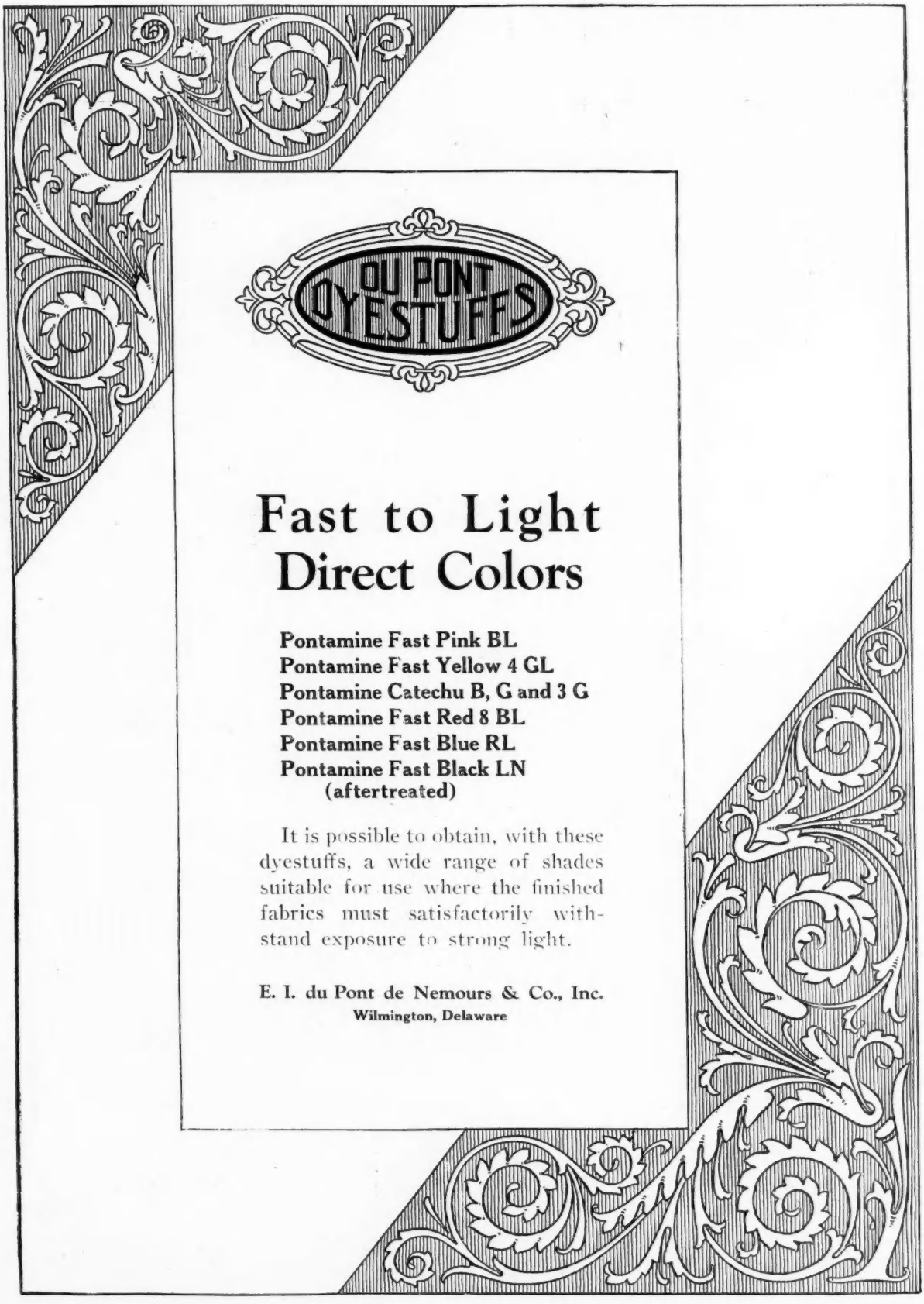

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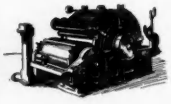

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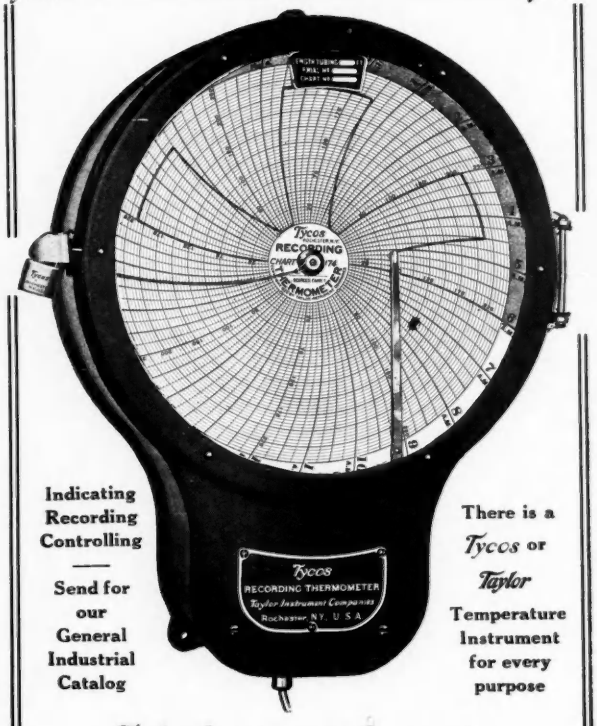

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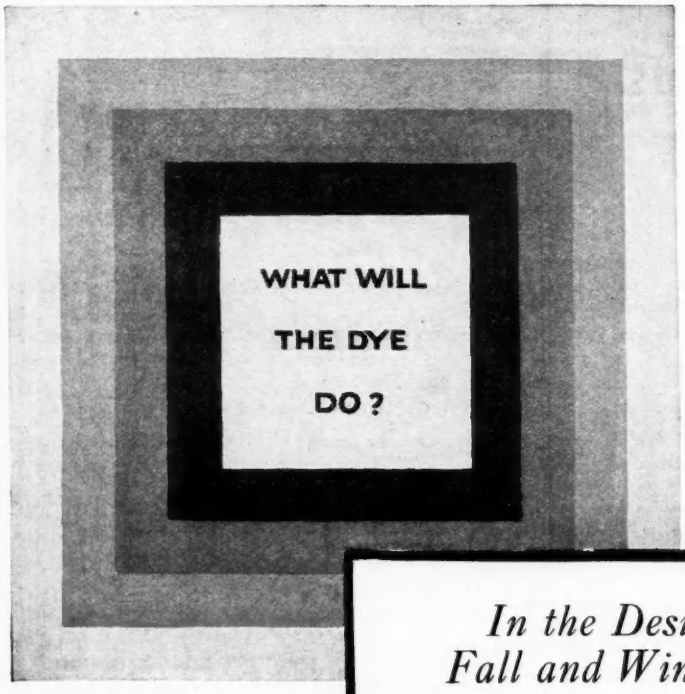

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VOLUME XII NEW YORK, NOVEMBER 5, 1923 NUMBER 23

The Spectroscope and Spectrophotometer, and Their Application to the Identification and Analysis of Dyes

Part II

Kruss Spectral Apparatus—Polarization Method—Koenig-Martens Spectrophotometer—Color Analyzer

By H. WALES

Associate Chemist, Color Laboratory, Bureau of Chemistry

Kruss Universal Spectral Apparatus

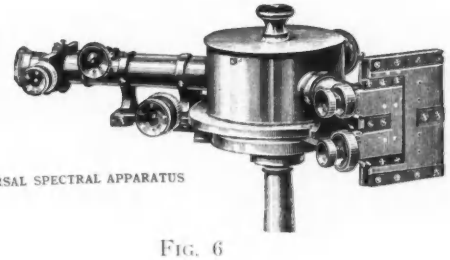
THE oldest type of spectrophotometer consists simply of a prism spectrometer with a double slit in the collimator tube (Fig. 6). This produces a divided spectrum, the intensity of either half of which can be changed by opening or closing the corresponding slit. Unabsorbed light passes into the upper slit and the light transmitted through the solution enters the lower slit. Measurements are made by varying the widths of the slits until the two halves of the field as seen in the eyepiece are of equal illumination. The intensities of the beams are then determined from the readings on the slit drums. For example, equal intensity might be obtained when the upper slit is set at 30 and the lower at 100. In such a case 30 per cent of the original light is transmitted by the solution, and

$$\frac{I_1}{I_0} = \frac{30}{100}$$

hence,

$$E = -\log \frac{I_1}{I_0} = -\log \frac{30}{100} = 0.523$$

In order to obtain monochromatic light in any spectroscope, the slit must be as narrow as possible. It is obvious that with two slits opened to different widths a much wider band is obtained from one than from the other. Since the wave lengths at the red end of the spectrum, as produced by a prism, are crowded together, errors due to this cause will be magnified here. This difference in slit widths also renders it impossible to obtain readings on the edge of a sharp absorption band. In such a case the field will be much darker on one side than on the other, while closing the upper slit will diminish equally the intensity of the comparison beam throughout the whole region. On viewing such a point in the spectrum the two beams will be seen, one of equal intensity throughout and the other dark on one end and bright on the other.



UNIVERSAL SPECTRAL APPARATUS

FIG. 6

To overcome these difficulties the more modern types of spectrophotometers make use of two slits which are always of the same width or else pass the two beams through different parts of the same slit. The intensity of the unabsorbed beam is regulated either by means of a train of Nicol prisms, which is known as the polarization method, or by means of a rotating sector.

Polarization Method

A beam of light as we ordinarily see it consists of a great number of waves traveling in the same direction but vibrating in different planes. If by some means this beam is transformed so that all the waves will vibrate in the same plane, the light is said to be plane-polarized. When a beam of light is passed through certain crystals, such as quartz, Iceland spar or tourmaline, it will be found that two beams are produced which are polarized at right angles to each other. One of these beams obeys all the laws of refraction, and is known as the ordinary ray. The other will not obey these laws, and is known as the extraordinary ray. A very convenient method of separating these rays is by means of a Nicol prism. This consists of a rhomb of Iceland spar cut into two parts, as shown in Fig. 7. These two parts are cemented together with Canada balsam. When the beam of light is passed through this prism the ordinary ray is totally reflected when it strikes the balsam layer, and is absorbed by a coat of black paint, while the extraordinary ray is only slightly refracted.

If a second Nicol is rotated in the beam emerging from the first prism, it will be found that at two positions no light will be transmitted by the second Nicol, and midway between these positions practically all the light is transmitted. At intermediate positions the intensity of the light emerging from the second Nicol will be less than that transmitted by the first. By measuring the angle between the two prisms the fraction of the light transmitted by the second Nicol can be computed.

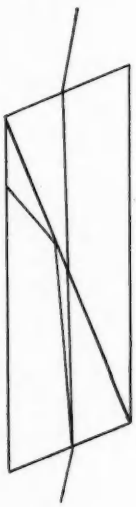


Fig. 7 *Path of Light Through a Nicol Prism*

The spectrophotometers using this polarization method may be divided into two types, those on which both beams are polarized and those in which only one beam is polarized. These types may be illustrated by the Koenig-Martens spectrophotometer and the Hilger spectrometer equipped with the Nutting photometer.

Koenig-Martens Spectrophotometer

The optical system of this instrument is shown in vertical section in Fig. 8. Light from a suitable source is split by a double lens (not shown in figure) into parallel beams which illuminate the two slits S. These slits are controlled by the same screw, and both are therefore always of the same width. After passing through the slits the light is further rendered parallel by the lens D, and passes through the prism P, where it is refracted and dispersed into two spectra. The Nicol prism N further divides the two spectra into four, the two outer of which are excluded by the lens L. The two inner spectra are plane-polarized and with their vibrating planes at right angles. When viewed through the analyzing Nicol A, two fields of the same color are seen. When the Nicol is placed at 45 deg. both fields are of equal intensity, at 90 deg. one field is bright and the other dark, and at 0 deg. these are reversed. This is repeated for each quadrant of the circle of rotation.

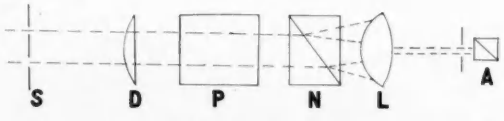


Fig. 8—*Koenig-Martens Spectrophotometer*

For this machine the ratio of the transmitted light to the original light $\left[\frac{I_1}{I_0}\right]$ is given by $\tan^2 \alpha$ where α is the angular setting of the Nicol, and

$$E = -\log \tan^2 = 2 \log \cot \alpha$$

The usual custom is to take readings with the cell before one slit and then the other. This will give two settings of the Nicol, one on each side of 45 deg., or the corresponding angle in any other quadrant, and the formula becomes

$$E = \log \tan \alpha_1 + \log \cot \alpha_2$$

The drum which moves the observing tube of this instrument is graduated into revolutions and fractions thereof, and should be calibrated in wave lengths before the machine is used. The field seen through the eyepiece covers on the average a region of about 100 Angstrom units For this reason, when a reading is made on the edge of a sharp absorption band one side of the field will be darker than the other, and a good match of the intensities of the two beams cannot be obtained. This is somewhat taken care of by means of an adjustable slit placed in the observing tube directly below the analyzing Nicol, which serves to narrow the field.

The wave-length calibration of this machine is slightly different from most. The eyepiece, which consists of the analyzing Nicol prism, is removed and the ocular slit narrowed as much as practicable. The drum which moves the observing tube is then rotated until the edge of the particular line used for the measurement falls on one edge of the slit, and the reading recorded. This is then repeated for the other edge of the slit. By obtaining a number of readings and taking the average, the drum setting is found for this particular wave length. This process is repeated for a number of points in the spectrum and a curve obtained

showing the drum readings which correspond to each wave length.

Hilger Wave-Length Spectrometer with Nutting Photometer

This apparatus consists of a single slit spectrometer with a Nutting photometer mounted in front of the slit. The telescope and collimator are fixed at right angles to each other and the prism is mounted on a movable table. The drum which rotates this table is graduated to read wave lengths directly. The optical system of the photometer box is shown in Fig. 9. Light from a suitable source is split into two parallel beams and enters the photometer through two orifices O and O′. The side of the cell containing the solution to be measured is placed before O′ and that containing the pure solvent before O. Light from O′ is totally reflected at X and again at B by the prism C. The unabsorbed light from O is polarized by the Nicol A and passes into B, where the two beams are brought into the same field. These two beams of light are again rendered parallel by the lens L, and then pass through the analyzing Nicol N into the collimator of the spectrometer, the eyepiece of which may be equipped with a shutter to exclude all except a very narrow band of the spectrum.

The scale on the analyzing Nicol is graduated on one side to read degrees of rotation and on the other side to give the extinction coefficient directly. In this type of instrument the absorption of a beam of light by any object is compared with the absorption of polarized light by a Nicol prism, and is given by the formula

$$\frac{I_1}{I_0} = \cos^2 \alpha$$

and

$$E = -2 \log \cos \alpha$$

where α is the angle through which the analyzing Nicol is rotated.

This type of machine has several advantages over the ones previously described. In the first place, only one beam is polarized, and this beam only will be affected by rotating the analyzer. This permits a much greater rotation of the Nicol to match the intensities of the two beams, and consequently a greater accuracy in the setting and determination of E. Only one slit is used, thus eliminating the possibility of unequal illumination due to different apertures. The intensities of the two beams are matched along the line at the center of the cross-hairs, and the narrowness of the spectral band over which this is done will depend entirely on the skill of the observer. Finally, the photometer box is easily removed and the spectrometer may be used for line spectrum work. The fields as seen through the eyepiece for this instrument and the Koenig-Martens are shown in Fig. 10.

Color Analyzer

Instead of using Nicol prisms to vary the intensity of the light, we may use what is known as a rotating sector. A machine using this principle and known as

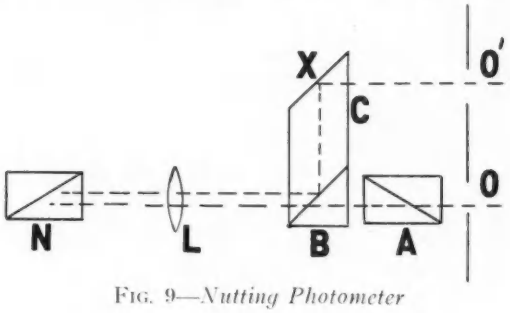


Fig. 9—*Nutting Photometer*

a "Color Analyzer" has recently been placed on the market by Keuffel and Esser.

Disks from which segments have been cut are rotated in the two beams of light by means of an electric motor. The beam of light which is absorbed by the solution under investigation is passed through the fixed part of the sector, and the unabsorbed beam is passed through the variable part, the segments of which may be altered while the sector is rotating. Since the amount of light transmitted by each sector will depend on the fraction of the sector through which the light can pass, the absorption can be measured by varying this opening. For illumination, light from

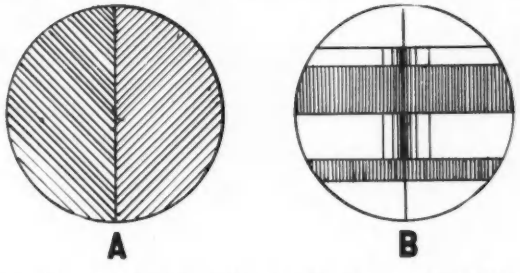


Fig. 10—(*a*) *Field of Koenig-Martens;* (*b*) *Field of Hilger Machine*

two 500-watt lamps is reflected into the photometer from blocks of magnesium carbonate, placed in the back of the lamp box. If it is desired to obtain the reflection spectrum of a sample the upper block of magnesium carbonate is removed and the sample inserted in its place. All parts of the instrument, including the lamp box, are rigidly mounted on a metal base, which keeps them in the proper alignment. The wave-length drum is direct-reading, as is the drum regulating the sector, which is calibrated to give the per cent of light transmitted. The field seen through the eyepiece is similar to that of the Koenig-Martens spectrophotometer.

(*To be continued*)

Dyestuffs Employed in Jig Dyeing

Part II

Direct Colors—Sulphur Colors—Basic Colors

By JOHN F. WARNER

1.—Direct Colors

THE method by which the color is applied to cloth on the jigger is, as has been noted above, by passing the cloth through the dye solution a sufficient number of times to attain the proper depth and tone of shade desired. In dyeing with the direct colors, few precautions are necessary, and it is comparatively easy to produce good work. For light shades or a small lot when a few jigs only are used, the dyestuffs are usually weighed out and dissolved together in a pail. The dissolved color, after being strained through a fine cloth, is then added to the correct volume of water in the jig, the machine started, and the cloth given the requisite number of "ends." The dyestuff is preferably added in several portions to insure an even shade. For example, if the dyer wishes to give the roll of cloth four passages or "ends" through color before cutting out his first patches, experience has shown that it will be most advisable to add one-half the amount of dissolved color before the first "end," and then run the next two "ends" without further addition of color. If a heavy shade is being dyed, the best method is to give one-quarter of the color to each of the first four ends. This tends to prevent part of the roll being dyed heavier than the balance. It is well worth while to exercise this care in adding the concentrated dyestuff solution to the dye vat, for an unevenly dyed roll usually requires a "stripping" or discharging of its color, to correct. Common salt or Glauber salt is usually added on the last two passages, and with most of the direct dyes aids materially in increasing the depth of shade obtained. In this connection it may be added that the laboratories of the dyestuff manufacturer are oftentimes of invaluable aid in working out problems of the exhaustion of various combinations of colors. Their chemists, in co-operation with the mill chemist and dyer, may be made a powerful factor in reducing dyehouse costs.

If assistants are to be used in conjunction with the dyestuff, their nature and the amount used will determine when it is best to add them to the bath. In this connection, it may be stated that many dyers do not sufficiently avail themselves of the service offered by the dyestuff makers in working out the best methods for producing the desired results with the colors at hand.

The large American dye makers without exception maintain research laboratories for the solution of problems which may arise in the application, as well as the manufacture of their various products, and for the most part they welcome the opportunity of assisting the practical dyer in his problems. The writer recalls a recent experience which showed the mutual benefits that may be derived from such co-operation. The dye works in question was using a direct blue dye of a type that was of satisfactory fastness, etc., but gave a shade somewhat duller in jig dyeing than in padding work. After an investigation and a series of experiments by the dye chemist, the mill chemist and the dyer, it was found that the dyestuff in question contained a small percentage of an uncombined intermediate used in its manufacture. This intermediate, which had a low tinctorial power, was not attracted to the cloth in the quick immersion on a padding machine, whereas in the course of an hour's running on the jigs enough of it was absorbed by the cotton fiber to dull appreciably the shade.

Instances of this sort are not unusual, and show clearly the value of thoroughly knowing the nature of the dyes to be used. When the dyer is in possession of this information, it is a comparatively easy matter to use accurately the assistants most helpful in obtaining good work. As a general rule, the same precautions with reference to alkaline soaps, salts, etc., apply to jig dyeing the direct dyes as were above stated with respect to padder work.

2.—Sulphur Colors

While the methods used in the preparation, as well as the dyeing of cotton piece goods with direct and basic dyes are fairly well standardized throughout the industry in this country, the same cannot be said of the use of sulphur colors. It is almost safe to say that no two mills use the same process. One finds in the finished goods markets for this type of dyed fabric practically every degree of fastness, penetration, uniformity, cleanliness, and finish. The methods of preparation for dyeing vary from the very simplest to the most expensive, and involved of any employed in cotton piece goods dyeing and finishing. The cheaper finishes are employed principally on low-grade twills and drills. These goods are used in the manufacture of low-priced working clothing, where the cost of every item entering into its production must be kept to a minimum.

The practice in many dyehouses running this cheaper class of work on the jigs is simply to open the bales, sew the pieces end to end as usual, then wind the cloth up on rolls. These rolls run from four hundred to nine hundred or more yards in length, depending of course

on the weight of the cloth and size of the jigs. The rolls are then taken to the jigs and prepared for dyeing by passing for a period of from thirty minutes to one hour or more through a solution of a malt compound. This treatment will either break up or thoroughly remove the starch used in sizing the gray cloth—depending on the strength of the solution and the length of time given. The function of the malt preparation is to convert the starch into a soluble sugar, which may be easily washed out, and hence leave the fiber in condition to absorb more readily the dyestuff. It has become the practice in some weaving mills to size and weight up heavily the warp yarns used in making low-grade twills and drills, and unless such sizes are very thoroughly and evenly removed, it is next to impossible for the dyer to obtain good penetration or a uniform shade when using sulphur colors in the jig. After malting, the cloth is given several passages through hot water to wash out the converted starch, and is then passed into the sulphur color solution.

A treatment such as this accomplishes but one thing. It makes the fiber more absorbent and hence aids penetration. Obviously it cannot do much towards producing a clean piece of sulphur dyed goods, and within the past few years it has been the finish more than the dyeing that has been scrutinized by the cotton piece goods merchant. One of the principal underlying reasons for this attitude has been the rapid strides made by the domestic manufacturers of sulphur dyestuffs. Many of the American-made sulphur colors are brighter and more soluble than the best pre-war types, and as a result it has been less difficult to obtain good dyeing. The principal efforts of the American dyeing and finishing plants have been directed therefore towards cleaner finishes.

For the better grades of cloth, singeing is necessary. This operation may be carried out on either a gas or a hot-plate machine. If a gas singer is employed, it should have at least six rows of burners for very clean work. When a shorter machine is used, several runs may be necessary before the small hair-like fibers are burned off completely. The speed of the gas singer may be adjusted for a production of seventy or more yards per minute where a good pressure of gas is available. If the plate singeing stove is used, a speed of one hundred yards per minute may be safely reached. As a general rule the plate singer gives a cleaner face to the cloth than the gas. The initial cost of installation as well as the upkeep is much higher than for the gas machine, however, and for this reason it has not found general favor for sulphur dyed work.

Many mills now singe and desize the cloth in one operation. This is accomplished by attaching to the delivery end of the gas singer a box arranged with squeezing rollers, so that the cloth after singeing passes directly into the malt preparation. It is then run into boxes and allowed to stand for several hours or overnight, after which it is well washed. The washing is carried out on a four or six compartment machine, and best results are obtained when there is a good flow of hot running water in the last two compartments.

While the above methods give sufficiently good results for most grades of sulphur dyed fabrics, it is sometimes necessary to bleach the cloth in order to have the finished result meet the requirements of the consumer. Except in the case of light-weight sheetings and print cloths, which may safely be boiled in open wooden kiers or iron kiers draped with heavy burlap, any cotton piece goods to be dyed with sulphur colors should be bleached in the open state. Otherwise there is usually present in the dyed piece a large number of streaks, which appear wherever the face of the cloth has been bruised or rubbed while in the rope state.

The bleach on jigs usually consists of six or eight passages through a strong solution of hot caustic soda and soda ash, followed by a souring with sulphuric acid, then a number of passages through a weak solution of sodium hypochlorite, another sour, and a through wash. In such a long process there is very apt to be a variation in the shade of the rolls after dyeing, due to variations in the handling on the individual jigs. In addition, such a method of bleaching adds materially to the cost, and is most certainly not to be recommended unless conditions warrant the risks involved.

Inasmuch as most of the sulphur colors are not soluble in water, but require the addition of sodium sulphide to the bath to bring them into solution, it is extremely important to know the correct amount of sulphide necessary. This will vary with the different individual colors and combinations of colors from one-half to two times their weight of concentrated sodium sulphide. Sodium sulphide is usually available in two forms, the crystalline salt and the fused salt, the latter being about twice the strength of the crystalline product. In spite of the great relative difference to the dyer from the viewpoint of uniform results, the writer has known of several mills where the dyehouse was not supplied with the same strength of codium sulphide continuously, because of failure to realize the importance of this assistant.

After dyeing and after-treatment, if necessary, the rolls of cloth should be well washed. This will serve a twofold object—to prevent subsequent tendering and to help obtain a uniform finish. If even a trace of sodium sulphide is left on the cloth, under favorable conditions this may gradually oxidize and the free sulphur change to sulphuric acid. Instances of this are seldom met with in practice, but it is well worth while to take no chances.

3.—Basic Colors

The reaction of the public from the dull shades so much in vogue during war-time has considerably increased the use of basic colors on cotton piece goods. Basic colors as a rule require much closer supervision and attention to detail in order to obtain good results than do direct or sulphur colors. Inasmuch as these colors have practically no affinity for cellulose, which

constitutes the principal component part of the cotton fiber, it is necessary to apply to the cloth a material which is capable of subsequently combining with the color. Such a material is called a mordant. Cotton piece goods may be mordanted on either the jig or the padding machine. The amount of cloth to be dyed determines the method and the machine. Small runs of cloth are best handled on the jigs, while long runs ranging from six thousand yards and upwards, are most economically prepared on the padding machine.

The principal mordant used is an insoluble tannate formed by impregnating the cloth with a solution of tannic acid and then fixing the tannin with an antimony salt, usually tartar emetic. When prepared on the jig, a roll of cloth weighing 100 pounds is given four runs hot through a solution containing eight pounds of tannic acid, and without washing is then given four runs through a solution of six pounds of tartar emetic. After being washed twice through cold water, the cloth is ready for dyeing. If the preparation is carried out on a padding machine, the tannic acid solution contains about six ounces per gallon, and the antimony salt about three ounces per gallon of water. If convenient to do so, the tannic acid bath may be used continuously. It is very important to wash the material thoroughly after fixing. Probably the most common defect in cotton goods dyed with basic colors is rubbing of the color, which is due to antimony not thoroughly fixed on the fiber.

After the wash in cold water, the basic color solution is added to the jig and the dyeing is usually finished in four runs. To insure level dyeing, it is advisable to keep the bath cold for at least the first two runs, and to add the color in several portions. To prevent dye spots due to precipitation of the color by hard water, it is necessary to correct the water with acetic acid. An acid bath will also help to procure level dyeing by retarding the absorption of the dyestuff.

When heavy bright shades are required it is oftentimes quicker and cheaper to dye the cloth with direct colors to a depth which permits topping with basic to the desired shade. This is an easy and thoroughly practical method, due to the fact that the basic colors are usually sold in the form of salts of color bases, and the direct colors in the form of salts of color acids. It is thus possible for the color base to join with the color acid, and form compounds which render the dye fast. Viewed as a class, however, the basic colors are of value to the cotton jig dyer principally because of their brightness. Their fastness to light is usually very poor and to washing fair.

Scientific Washing

Part VI—Alkali

(Continued)

By F. H. GUERNSEY
Chief Chemist, Cowles Detergent Company

Bicarbonate of Soda ($NaHCO_3$)

BICARBONATE OF SODA, or ordinary baking soda, is seldom used alone as a detergent alkali, because when dissolved in water it yields practically no hydroxyl ions and its value as an aid to soap is therefore practically nil.

Bicarbonate is a compound of sodium with hydrogen, carbon and oxygen. The presence of the hydrogen causes it to behave as an acid toward caustic, and the reaction between the two results in the formation of soda ash. This explains the statement sometimes heard that "soda bicarb. takes the sting out of caustic."

Sodium bicarbonate is quite unstable. Like a stone wall loosely cemented, it easily breaks up. In the presence of moderate heat, sodium bicarbonate is decomposed into soda ash and gaseous carbon dioxide, shown in the following reaction:

$2NaHCO_3$ (soda bicarbonate) + heat = Na_2CO_3 (soda ash) + H_2O (water) + CO_2 (carbon dioxide gas)

Thus it is apparent that if used at washwheel temperatures, or boiled in the soap tank, conversion into soda ash will occur. To the extent that soda ash is formed, some value may be derived, but this procedure is obviously a roundabout and costly method of securing detergent value.

We have known launderers to employ sodium bicarbonate along with caustic "to neutralize the caustic effects" of the latter. This is nothing more than washing with soda ash, since, as pointed out above, soda ash will be the result of such combination.

Sodium bicarbonate is without value as a water-softening agent unless converted into soda ash, in which case sodium bicarbonate loses its identity.

To sum up the value of sodium bicarbonate, it might be said that this material has no legitimate use as a detergent alkali.

Modified Sodas

Modified sodas consist of, or are equivalent to, mix-

(Continued on page 816)

The Moisture Content of Wool—Its Relation to Scientific Theory and Commercial Practice*

By S. A. SHORTER, D.Sc.

THE subject of water in wool may be considered from three points of view: (1) Commercial, (2) scientific, and (3) technical. The commercial point of view originates in the fact that water is cheaper than wool, and is concerned primarily with conditions of fair bargaining between buyer and seller, with the fixing of standards of regain and with commercial testing. From a scientific point of view, wool is regarded as a hygroscopic colloid whose water content depends upon its colloidal state and on the circumstances in which it is placed, and whose properties depend upon its water content. The technical point of view includes something from both the above. For example, the conditioning of worsted yarn is necessitated by certain commercial considerations, but the actual process depends upon certain scientific principles. Moreover, unsuitable methods of conditioning may give rise to commercially undesirable results in the finished piece. The causes of such conditioning faults and their avoidance are matters of scientific inquiry.

Standards of Regain.—It is customary to express the moisture content of wool as a percentage of the dry weight. This percentage is called the "regain." In commercial testing the dry weight is obtained by heating in a current of air at about 240 deg. Fahr. till the weight appears to be constant. From a scientific point of view this method is open to criticism on three grounds. In the first place, air heated to 240 deg. Fahr. has a small, but in warm, humid weather a by no means scientifically negligible, relative humidity. Secondly, the customary method of determining when the weight is constant merely determines when the rate of loss is less than a certain amount (which depends upon the sensitiveness of the balance and the interval between consecutive weighings). If the rate of loss of moisture proceeded according to the simplest possible law—viz., that the rate is proportional to the residual amount—the error involved could readily be estimated (and shown to be negligible in the ordinary commercial method). It is possible, however, that the later portions of moisture come off at a rate, relative to the amount present, much slower than that of the earlier portions, so that prolonged heating would cause an unexpectedly large amount to come off. Thirdly, a certain amount of moisture may never come off at all till the temperature is raised above a certain point—i. e., the "dry weight" obtained may depend upon the method of drying.

The third point is of no practical importance. All that is wanted commercially is an accurately defined quantity which may be called the "dry weight." Moreover, it may be that wool parts with more and more of its moisture as the temperature is raised, until it begins to char. If this is the case there is no such thing as an absolute "dry weight," and all we can ever deal with is an arbitrarily defined quantity.

The second point will not be a serious matter so long as the routine of the drying process is kept the same. Any alteration in the routine, such as the use of a more sensitive balance and longer intervals between the weighings, might give different results.

The first point will be negligible in the English climate except perhaps in warm, humid weather. In a warmer climate it might be a serious matter and involve the use of some correction for the humidity of the air used in drying.

Standards of conditioning have been fixed by the various Conditioning Houses for wool in different forms. Among those fixed by Bradford Conditioning House[1] are: Tops in oil, 19 per cent; tops dry, 18¼ per cent; yarn, 18¼ per cent; cloth, 16 per cent. The standards of regain were fixed before the subject had been studied very extensively from a scientific point of view, so that it is not surprising that there is considerable difference of opinion among practical men as to their suitability. The difference between the standards for dry and oiled tops is contrary to what one would expect on scientific grounds. On the other hand, the lower standard for cloth seems reasonable, since we should expect the finishing processes to exert, if anything, a deleterious effect on the moisture-absorbing power. The most serious objection on the part of practical men seems to be the 18¼ per cent standard for yarn, which is regarded as too high. The rapid and even conditioning of yarn to this standard is a difficult matter, and uneven conditioning may lead in certain cases to faults in the cloth.

The Equilibrium Between Wool and Atmospheric Moisture

In view of the technical importance of the absorption of water by wool, it is surprising that so few data are available. The only extensive research on the subject is that of Schloesing,[2] and this, though valuable as far as it goes, is limited in scope. A number of papers have also been published by Hartshorne.[3] The elaborate charts and tables contained in these papers rest, however, on a very slender and insecure experimental foundation, and are all the more misleading

*A paper read before the Midlands Section of the Society of Dyers and Colourists, and published in the Journal of the Society.

because of their elaboration and high degree of mathematical accuracy. In view of the earlier and more accurate work of Schloesing, Hartshorne's experimental work cannot be regarded as possessing any scientific value. The results given in the 1905 paper are grossly erroneous at high humidities. The results given in the 1911 paper are in somewhat better agreement with Schloesing's results, but there is nothing in the experimental part of the paper to justify the elaborate table given at the end, in which the regains are calculated to two places of decimals and in which the humidity ranges from 0 per cent to 100 per cent. The papers subsequent to this paper contain no new experimental data. In addition to weakness on the experimental side, Hartshorne's work shows serious theoretical deficiencies. Toward the end of the 1911 paper are given a number of so-called "laws of regain." The first of these, called "the general law for cotton and worsted," is quite meaningless; the second, on examination, reduces to the mathematical truism that an equation with four constants can be made to fulfill four independent conditions. The third law states a law for worsted: "For the same humidity the squares of the regains at different temperatures are to each other inversely as the cubes of the corresponding absolute temperatures." This law is intelligible, but it rests on a very insecure experimental basis and is open to objection on theoretical grounds. The fourth law is a similar law for cotton, open to objection on the same grounds.

The above criticism of Hartshorne's work, which may appear somewhat severe, is necessary owing to the fact that its voluminousness as compared with the excessive conciseness of Schloesing's work is apt to give a very erroneous impression of the relative merits of the two.

After the above preliminary remarks, we will confine ourselves to a consideration of Schloesing's work. Schloesing measured by means of the chemical hygrometer the humidity of air in equilibrium with wool containing various amounts of moisture. His measurements were taken at three temperatures—12, 24 and 35 deg. Cent. He experimented with two kinds of wool, described as "Buenos Aires crossbred wool" and "Port Philip merino wool combed." His results for the two extreme temperatures are shown in Fig. 1. It will be noticed that the results for the merino and crossbred fit the same curve.*

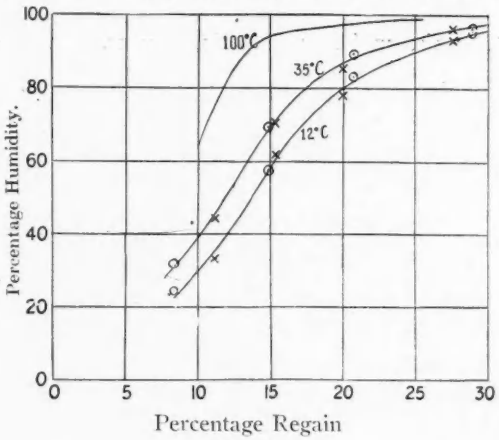


FIG. 1.

Schloesing's results for the Equilibrium Regain of Wool at 12 and 35 deg. Cent., with hypothetical curve for 100 deg. Cent.

X Crossbred.
O Merino.

The general shape of the curves is significant. They are steepest in the middle and tend to become flat as saturation is approached. We may regard the ordinates of the curves as the vapor pressure of the water in the wool (expressed as a percentage of the vapor pressure of pure water). When the regain is small, the vapor pressure is small, indicating that the water is distributed in the wool in a molecular degree of fineness. As the regain increases the vapor pressure increases, not merely absolutely but also relatively to the amount of water present. At a regain far removed from saturation the vapor pressure becomes nearly equal to that of pure water. From this point onward the vapor pressure increases more and more slowly as saturation is approached. This part of the curve is quite different from the corresponding part of the vapor pressure curve of, say, water in ether. The latter curve would show no special flattening in the neighborhood of saturation, but would pass with perfect continuity of slope into a portion corresponding to supersaturation. The last portion of the water-in-wool vapor pressure curve denotes a change in the nature of the process of absorption. As the wool approaches saturation the process is approximating to a simple coarse-grained soaking up of water, such as occurs with a sponge. The vapor pressure of the water in a wet sponge is equal to that of pure water whatever the water content, so that the vapor pressure "curve" is the 100 per cent humidity line—to which form the water-in-wool vapor pressure curve gradually approximates.

This gradual change in the nature of the process of water absorption is shown in other ways. The water is readily evaporated from saturated or nearly saturated wool. As the wool becomes drier the water is parted with less easily (even when allowance is made for the diminished amount present), till finally the last portions are driven off with great difficulty. Another phenomenon which shows this difference is the evolution of heat which accompanies the absorption of water, which is very great for dry wool and approaches zero at saturation. This effect is quite different from the case of substances which go into true solution

*The results plotted are taken from the Manchester Chamber of Commerce Testing House reprint of the Textile World Record paper—the only work accessible to the lecturer

right up to the point of saturation (e. g., water in ether). Such substances have a finite heat of solution right up to and beyond the point of saturation. The heat of solution in the neighborhood of saturation may be less than at low concentrations, but it will still be finite owing to the fact that the process of solution is of a molecular degree of fineness just as at low concentrations.

The equilibrium regain depends upon both the relative humidity and temperature of the air. The ordinary variations of humidity which occur during the year produce much more effect than the corresponding variations of temperature. Thus at 55 per cent humidity an increase of temperature from 12 to 35 deg. Cent. (a very large increase from a meteorological point of view), causes a decrease of about 1.2 per cent in the regain, which is equal to the effect of a decrease of about 7 per cent in the relative humidity (meterologically quite a small change). Hence, when we consider natural variations we may say that the regain depends chiefly on the relative humidity and only slightly on the temperature.

When we come to consider variations of temperature outside the meteorological range, we may get quite considerable effects. There are no data available relating to the regain of wool at high temperatures. We may, however, form very rough curves by extrapolation from Schloesing's results. Such a hypothetical curve for 100 deg. Cent. is shown in Fig. 1. Such high temperature curves are of importance in relation to hot-pressing processes in which wool is heated under conditions which do not allow of rapid escape of moisture. Let us imagine a whole series of curves to be drawn in Fig. 1 at, say, degree intervals of temperature. Heating wool in a closed space, mainly occupied by wool (to which hot pressing approximates), corresponds to traveling across the curves along a line of constant regain. As the wool warms up, the air between the fibers become more and more humid, and if the regain be high enough may ultimately become saturated. We thus see that in hot-pressing a wool fabric becomes actually moister and may even become saturated and actually wet, although its moisture content remains practically constant.

As pointed out by the lecturer[4] some years ago, the fact that the regain diminishes with rise of temperature at constant relative humidity has a certain theoretical significance. It denotes that the absorption of water is accompanied by the evolution of heat. It is possible by means of a well-known thermodynamical formula to calculate the heat of absorption from the regain data. The statements in a preceding paragraph regarding the heat of absorption are based on some unpublished calculations from Schloesing's data. The heat of wetting of wool and other colloidal substances is sometimes referred to as the heat of swelling. This is an inappropriate name, since the heat is evolved mainly in the earlier stages of water absorption before appreciable swelling occurs.

The Rate of Gain or Loss of Moisture.—When wool is out of equilibrium with the surrounding atmosphere, it will gain or lose moisture according as its actual regain is less or greater than the equilibrium regain. The rate of this gain or loss will depend upon a variety of factors. For the same wool in the same form it will depend upon (a) the humidity of the air, (b) the temperature, (c) the actual regain of the wool. For the same wool in different forms it will depend upon (d) the form of the wool (e. g., loose yarn or cheese). For different wools it will depend upon (e) the nature of the wool (e. g., coarse or fine, scoured or extracted).

We will consider here factors (a), (b) and (c). The rate of gain or loss will diminish as the actual regain approaches the equilibrium regain. The simplest law we can assume is that the rate is proportional to the difference between the two regains. This leads to the following simple law: In equal intervals of time the difference between the actual and equilibrium regains diminishes in the same ratio. Thus, if the equilibrium regain is 20 per cent and the wool goes from 10 per cent to 15 per cent in the first hour, in the next hour it will go from 15 per cent to 17.5 per cent; in the next to 18.75; in the next to 19.37; and so on. This law may be regarded as the first approximation to the actual law.

The above applies to variation of factor (c) only. Factors (a) and (b) will affect the rate in the first place by altering the equilibrium regain. Here, however, we get an important difference between the power of an atmosphere to produce (1) a high equilibrium regain and (2) a rapid rate of absorption. The final equilibrium depends mainly on the relative humidity and only slightly on the temperature. The *rate* of absorption is quite another matter. The moisture has to diffuse from the atmosphere, and at low tempera-

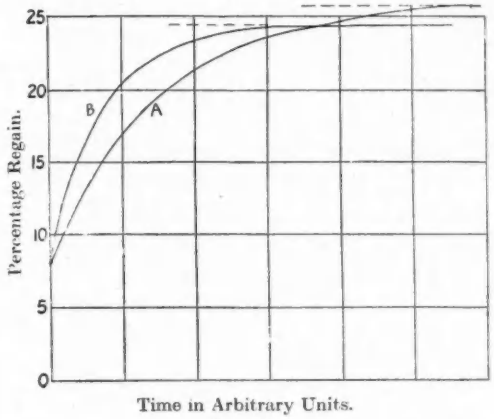


FIG. 2

Hypothetical curves for the attainment of Equilibrium in an atmosphere of 90 per cent Humidity.

A at 45 deg. Fahr.
B at 65 deg. Fahr.

tures the amount of moisture is so small that it has to be gathered from an enormous volume of air so that the process of absorption is very slow. Hence, for the same relative humidity the rate of absorption by relatively dry wool will increase very rapidly with the temperature owing to the rapid increase of the *absolute* humidity (in spite of the slight decrease of the equilibrium regain). To illustrate this point two curves have been drawn in Fig. 2, showing the approach to equilibrium of wool initially at 8 per cent regain in an atmosphere of 90 per cent humidity, (1) at 45 deg. Fahr., (2) at 65 deg. Fahr. The atmosphere contains in the first case 3.1 grains per cubic foot, and in the second 6.2 grains per cubic foot. On this account alone the rate of absorption will be much greater in the second case than in the first. On the other hand, the equilbrium regain will be slightly greater in the first case than in the second. The curves have been drawn on the assumption that the rate of absorption is proportional jointly to (x) the difference between the actual and equilibrium regains, (y) the amount of moisture present per unit volume of the atmosphere (absolute humidity). The equilibrium regains have been taken as (1) 25.8 per cent, (2) 24.3 per cent. When the wool is far from equilibrium, factor (x) is of little importance, so that the rate of absorption is much greater (almost twice as great) at the higher temperature. As equilibrium is approached this factor increases in importance and finally becomes the deciding factor.

Where time is no object we may condition wool to a high regain in a cool place (where the relative humidity is fairly high, but the absolute humidity low). For rapid conditioning we require a high humidity (corresponding to an equilibrium regain much higher than the desired regain) and a not too low temperature.[5] The best practice in conditioning yarn is in accordance with the above principles.

Similar considerations apply to drying. Air at a low temperature, even if perfectly dry, would be of little use for rapid drying owing to the small amount of moisture it can absorb.

The Relation Between the Moisture Content and the Properties of the Wool Fiber

All the technically important properties of the wool fiber depend essentially on the moisture content. We will consider here three classes of properties connected respectively with (1) the electrification of the fiber, (2) the relation between external faces and the resultant deformation of the fiber (the elastic properties), (3) the action of one fiber on another.

The Electrification of the Wool Fiber.[6]—This is a case of the electrification produced when two surfaces are brought into intimate contact and then separated. The liability of wool to electrify is partly due to the fact that it lies almost at the extreme positive end of the electrical series, so that practically all the substances which come into contact with it during processing tend to charge it in the same sense, positively. The most notable exception is the buff leather used for rubbing leathers in the French drawing process. Electrification of the wool fiber is of importance because of the trouble it may cause in a number of textile processes. With increasing moisture content electrical trouble diminishes owing to the increased electrical conductivity of the wool fiber. At temperatures below 60 deg. Fahr. there is an increasing tendency toward electrical trouble, probably owing to a hardening of the fiber, such as occurs with cotton at low temperatures.

The Elastic Properties.—These include tensile strength extensibility, the various kinds of elasticity (volume, shape, etc.), and those phenomena analogous to what are termed "elastic after-effects" in the case of metals.

Increasing moisture content causes a decrease in the tensile strength, an increase in the "extension at break," and an increase in the extension produced by a given increase of tension (i. e., a decrease of Young's modulus for the fiber). According to the experiments of Hardy,[7] the average tensile strength of a number of wool fibers was decreased from 315 milligrams per square hundredth of a millimeter to 243 by an increase of atmospheric humidity from 40 per cent to 80 per cent, while the "extension at break" was increased from 32 per cent of the original length to 39 per cent.

The most characteristic and important effect produced by varying moisture content is on what may be termed the "elastic after-effects." If a fiber is put into a state of strain when wet by the application of an external force, and then dried, it will remain approximately in its strained position when the external force is removed. The state of strain, though not requiring any external force to maintain it, still exists in a latent form, and can be made externally active again by rewetting the fiber. If, however, the fiber is treated with boiling water or steam the state of strain is obliterated and cannot be revived by subsequent treatment with cold water.[8]

We thus have three effects dependent essentially upon the water content: (1) The existence of latent strains in dry* fibers; (2) the revival of such strains by wetting; (3) their obliteration by steam or boiling water. To these we may add (4) the elimination, by the removal of external forces, of strains rendered active by wetting.

The Action of One Fiber on Another.—The action of one fiber on another and the technical significance of such action are very imperfectly understood at present. The subject is a difficult one owing to the complexity of the factors operating: the mere geometrical com-

*i. e., dry in the everyday sense of the term (which may mean a regain of 8 to 15 per cent.)

plexity of the various forms of silver (top, roving, etc.); the presence of superficial scales; the influence of foreign substances, such as soap and oil. It is not surprising, therefore, that those processes which depend essentially upon the action of one fiber on another (such as drafting in drawing and spinning) are less understood than those which involve the elastic properties (such as crabbing).

All that we can say with regard to the influence of moisture is that it increases the adhesion between the fibers and at the same time decreases their mutual friction. The two effects are not mutually incompatible, as appears at first sight. The lubrication of ordinary solid surfaces involves both effects in a similar manner. One result of the greater intimacy of contact and diminished friction produced by moisture will be that the direction of the scales will have a greater effect on the resistance to motion. This point is of importance in relation to the theory of milling.

Technical Applications

The simplest method of dealing with the technical applications of the foregoing general principles will be to consider separately a number of technical processes or properties.

The Strength of Yarns and Fabrics.—The increasing absorption of moisture is accompanied by (a) a decrease of tensile strength, (b) an increase of the "extension at break," (c) an increase of the extension produced by a given increase of tension (a decrease in Young's modulus). The main factors operative are evidently the corresponding effects on the single fiber, but diminished fiber friction will also play a part in cases where appreciable fiber slip occurs (e. g., a long length of softly twisted yarn).

Crabbing and Blowing.—These processes consist essentially of the elimination of strains by steam or boiling water. Thus, crabbing done before scouring has for its object the avoidance of the revival by wetting (in scouring) of irregular latent strains put in during processing.

Tentering.—This consists of putting the cloth in a state of strain when wet, and rendering the strain latent by drying the cloth.

London Shrinking.—This is primarily a revival and elimination of latent strain by wetting and then drying in the absence of external forces. At the stage of manufacture at which the process is done, the strain is merely a uniform extension in length or width which in the absence of external constraint disappears by the cloth shrinking. The process is, however, more complicated than this. In many cases the wetting causes an increase, and the drying a decrease of both length and width.[10] There may, moreover, be a third effect due to fiber entanglement—a species of mild milling. It is interesting to compare these three effects with respect to a repetition of the shrinking process. The first effect can occur only once. The second is a reversible effect which can go backward and forward any number of times. The third is an irreversible effect which can be repeated, perhaps indefinitely.

Milling.—Many theories have been put forward to explain the milling or felting of wool. None of these theories is generally accepted, and in the opinion of the lecturer none of them gives a satisfactory explanation of the process. No theory hitherto put forward fulfills both of two essential conditions—(1) that it should agree with the elementary facts relating to the fiber arrangement in milled fabrics; (2) that it should give a dynamically sound explanation of the mechanism of milling. Thus the well-known interlocking scales theory fails on the first ground—nobody has seen any interlocking scales. On the other hand, the theories of Ditzel and Lobner, which rightly attribute importance to the unidirectional freedom of motion of motion of the serrated fiber, fail on the second.

In the opinion of the lecturer, milling is primarily due to the fact that a wool fabric becomes, under suitable conditions of fiber contact (induced by moisture and still more by milling agents), a collection of self-tightening mechanisms; that is to say, mechanisms whereby the haphazard external forces acting on the fabric are transformed so as to produce a consistently consolidating effect.

The mode of action of these mechanisms requires a little examination. Let us suppose that, owing to the presence of moisture and possibly milling agents, the conditions of fiber contact are such that the direction of the scales plays an important part in determining the resistance to the sliding motion of one fiber over another Let us consider a single fiber in the midst of other fibers with which it is entangled at different points along its length. We may divide these entanglements into two classes: (1) those which are so tight that no motion is possible; (2) those in which there is sufficient freedom for the fiber to move, relative to the entanglement, in the direction of the root-end; i. e., in the direction favored by the serrations. If the fiber has along its length entanglements of the second class only, casual disturbances will cause it to travel as a whole through the fabric, just as barley awn, started the right way round, will travel up a person's sleeve. This state of affairs, though by no means infrequent among the short fibers of a woolen fabric, will, however, be exceptional. In general a fiber will have entanglements of both classes—it will be held tightly at certain places and free to creep at others. Let us now consider the case of a fiber which has an entanglement of class (1) at one place and one of class (2) at another. For convenience we will refer to these as "a place of complete entanglement" and "a place of partial entanglement" respectively.

There are two distinct cases: (a) where the scales on the portion of fiber between the entanglements point toward the place of complete entanglements;

(b) where the scales point toward the place of partial entanglement. In case (a) casual disturbances will tend to cause the fiber to creep so as to diminish the length between the entanglements. This length of fiber will therefore tighten up automatically. Any temporary deformation of the fabric which brings the two entanglements closer together will allow further creeping to occur, so that when the external force producing the deformation is removed the two entanglements will not separate to quite their original distance. There is thus a permanent local consolidation of the fabric. The action is similar to that of the self-tightening handcuff, which automatically tightens up as the prisoner struggles, and which is condemned on humanitarian grounds, because the prisoner cannot help causing it to tighten (just as the housewife cannot help milling a woolen fabric when washing it).

Let us now consider case (b). In this case casual disturbances will lead to an increase of the length of fiber between the two entanglements. If the fiber were a rigid rod this would tend to produce a local expansion of the fabric. Owing, however, to the lack of appreciable flexural rigidity of the fiber, it merely loops and ultimately becomes entangled with other fibers.

There are, therefore, two fundamental factors in milling: (1) unidirectional freedom of motion due to the serrations on the fiber; (2) lack of appreciable flexural rigidity of the fiber. The action of moisture and milling agents is to produce conditions of fiber contact favoring the operation of factor (1).

The looping action which occurs in case (b) will undoubtedly contribute indirectly to the milling effect by adding to the complexity of the fiber arrangement, but it cannot be regarded as exerting direct fabric-consolidating action. This point is emphasized because the theory which comes nearest to giving a correct explanation of milling fails on this very point. The theory is that of Lobner,[11] who writes: "The fiber begins, as we have seen, to felt at the root end. This end clings to the neighboring fibers, and while the tendency of the hair to move in the direction of the root continues, the root end, which has already felted sufficiently with other hairs, is hindered in its movements. Owing to the continued tendency to move away from the tip, it must finally wriggle into a spiral or loop, curl up and pull itself together (*sich zusammenziehen*)." This passage may be regarded as more or less a description of case (b). As an explanation it is dynamically unsound. Such a looping fiber would tend to produce, if anything, an expansion of the fabric by its very slight flexural rigidity, though, as we have seen, this effect will be negligible compared with the consolidating effect in case (a), produced when the fiber is in a state of tension. The dynamical unsoundness of the above theory is unconsciously revealed by its author in the naively question-begging final verb (*sich zusammenziehen*).

The theory put forward by the lecturer restores the scale structure to the position of primary importance from which it has been ousted by recent theories. It differs, however, from the classical "interlocking scales" theory in two respects. In the first it postulates unidirectional freedom, not absolute fixity, as the characteristic effect produced by the scales. Secondly, this unidirectional freedom involves the scales on the *entangled* fiber, not those on the *entangling* fibers. This point is well illustrated by an observation of Ditzel, who found that fibers enclosed in a cotton wrapper could actually be milled into the material of the wrapper.

Worsted Drawing and Spinning.[12]—The most suitable working conditions with respect to regain and atmospheric humidity have been fairly well determined empirically, though the rational basis of these conditions is not thoroughly understood.

For the English system of drawing, it is usual to start with tops at from 18 to 20 per cent regain. The exact maximum allowable regain amount is the greater the finer the wool, and the less the amount of oil it contains. Too great a moisture content leads to irregular drafting, and too small to electrical trouble. The best practice is to humidify the atmosphere to about 72 per cent humidity to prevent undue loss of moisture. This corresponds to from 17 to 18 per cent regain.

For the French system of drawing unoiled material, a much higher humidity is required—from 82 to 88 per cent being usual. This corresponds to a much higher regain (19 to 24 per cent).

For the spinning of English rovings the high humidities used in drawing are found to be deleterious. The most suitable humidity seems to be about 55 per cent. Though too high humidity leads to bad drafting and too low to electrical trouble, just as in drawing, the critical point is at a much lower humidity. Long fibered material seems more susceptible to the influence of high humidity than shorter fibered material.

The spinning of French rovings is by no means so susceptible to the deleterious influence of high humidity as the spinning of English rovings. French rovings may be spun in the room in which the drawing occurs. This high humidity does not seem to be necessary, as the spinning is often done at a lower humidity.

The above empirical rules, which may be said to represent the best commercial practice, involve a number of points which have not yet received scientific explanation. It is well known that excessive dryness gives rise to trouble owing to electrification of the fibers. It is, perhaps, less well known that the susceptibility to electrical trouble decreases as the material goes down the drawing (owing mainly to increased mechanical control of the fibers), and is least in the spinning. Hence a gradual loss of moisture is allowable during the drawing processes and a much lower

humidity is sufficient for spinning. No explanation seems hitherto to have been given of the deleterious effect of too high humidity in spinning English rovings and of the difference in this respect between English and French rovings.

The lecturer's view is that high humidity acts deleteriously by increasing the extensibility of the fibers. During drafting the longer fibers are momentarily subjected to considerable tension owing to their front ends being seized by the rapidly moving front rollers, while their back ends have only just emerged from the slowly moving back rollers and are held by the friction of adjacent slowly moving fibers. The shorter fibers will not be subjected to so great a tension. Moreover, the tension along a single long fiber will not be uniform—it will be greatest at the front end. The drafting process will therefore strain the fibers in an irregular manner. When the fibers emerge from the front rollers, this excess tension is removed and the fibers tend to return to the unstrained state. When the fibers are at a low regain, the excess tension causes very little extension, so that it does little harm. When the fibers have a high moisture content, however, considerable extensions are produced, and the subsequent irregular contraction of the fibers on emergence from the front rollers will cause a bad spin and bad yarn. In the case of English rovings, this effect will be very great owing to the twist, which will increase the resistance to drafting. The effect will be very much smaller in the case of French rovings, owing to the absence of twist and consequent ease of drafting. The difference may easily be shown by spinning a short length of each roving wet on an ordinary cap frame, putting in sufficient twist to make a spin possible in both cases. Both yarns, when released from all external tension, will assume an irregularly crimped form, but the yarn from the English roving will be very much worse than the other.

This theory explains, therefore, all the known facts relative to the bad effect of too high humidity. The greater susceptibility of long-fibered material (mentioned above) is readily explained. Long-fibered material will be subjected to greater irregularities of tension during drafting, owing partly to the greater absolute length of the longest fibers and partly to the greater variability of the fiber length.

High humidity may also operate adversely by giving rise to stickiness of the roller leathers. This effect will, however, operate only at very high humidities.

Weaving.—Since woolen and worsted yarns are stronger the drier they are, it might be thought that a low moisture content is good for weaving. Apart from the question of electrification, however, there is a purely mechanical reason why undue dryness is undesirable. During weaving, a warp thread has to stand not a definite variation in tension but a definite variation in length (in shedding), and what is required is not so much a high breaking tension but a not too low "extension at break." This latter quantity, as we have seen, is less the lower the moisture content. Tensile strength is, of course, desirable, but it must not be purchased at the expense of extensibility ("elasticity" in the popular sense); nor must an unnecessarily high extensibility be purchased at the expense of tensile strength. The most suitable regain for spinning is a compromise and seems to lie in the neighborhood of 16 per cent.

BIBLIOGRAPHY

[1] Bradford Conditioning House Handbook, p. 38.
[2] Schloesing: Bul. Soc. Encour. Indust. Nat., 1893.
[3] Hartshorne: Trans. of the New England Cotton Manuf. Assn., Sept., 1905; April, 1911.
[4] Jour. Soc. Dyers & Colourists, Dec., 1920, p. 299.
[5] See Dobson: Humidity in Cotton Spinning, p. 140 (Heywood, Manchester).
[6] Shorter: J. Tex. Inst., Apr., 1918, p. 6.
[7] Hardy: J. Agric. Research, XIV., Aug., 1918.
[8] Harrison: Proc. Roy. Soc., A94, p. 460, 1918.
[9] Barker, Barwick and Pickles: Tex. World Rec., 42, p. 516; see also the Manchester Testing House Handbook.
[10] See Posselt's Textile Journal, March, 1922, p. 53.
[11] Lobner: Studien und Forschungen uber Wolle und andere Gespinnstfasern, p. 230.
[12] Shorter: J. Tex. Inst., Aug., 1919, p. 218.

Color Matching on Paper

A Suggested Subject for Research

By J. Newell Stephenson, M.S.

ONE of the problems which is continually before a mill making a variety of colored papers, and one which occasionally causes considerable difficulty and some lost time, is the problem of matching the color of a sample. In the manufacture of paper there is no such thing as redyeing the product for the papers colored while in the form of pulp during the beating operation, and once it is fed to the paper machine and turned off in the form of a finished sheet there is nothing more to be done to change the shade or tint. It is necessary, therefore to add the proper kind and amount of dyestuff or coloring matter to the fibrous material in the beater, and it is sometimes difficult to determine accurately the exact requirement. The problem is further complicated by the fact that the dyestuffs used are of considerable strength, and consequently a small error in the measurement of the dyestuffs used in likely to make a considerable variation in the color of the finished product.

The fibrous materials used in the manufacture of paper are from various sources, and each has its own color to a certain degree; but there is no standard color for any of these substances, as that in itself will vary between lots from the same source. For instance, unbleached or even bleached sulphite or soda pulp would not run consistently of the same color, and rag

(*Continued on page* 809)

AMERICAN
DYESTUFF REPORTER

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto.

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AN APPEAL TO THE PROGRESSIVE ELEMENT IN TEXTILE-CHEMICAL CIRCLES

TWENTY-FIVE years ago the processes of dyeing, bleaching and finishing were largely rule-of-thumb operations. The dyers in our textile mills were chiefly of British origin—men who had received their training as apprentices and whose practical knowledge had been handed down through successive generations engaged in the same line of work. Technically trained textile chemists were largely products of the German universities or the laboratories of German dyestuff houses, and were almost exclusively employed by the latter. Very few American mills employed competent technicians, but depended upon the dyestuff houses from whom they bought their supplies for such technical advice as was necessary.

With the development of American textile schools a gradual change became apparent, and with the outbreak of the war the necessity of producing technically trained experts in various chemical lines stimulated tremendously the development for American talent in this direction. To-day the need of technical control is appreciated by nearly every textile manufacturer, and the rule-of-thumb men, although still present in large numbers, are rapidly being supplanted by well-trained technical men of the younger generation. The dyer, bleacher or finisher of to-day must know not merely *how* he does it but *why* he does it.

This increase in technical knowledge has developed side by side with improved methods, apparatus and machinery. No mill can now compete for long without modern laboratories and equipment.

We believe that our readers include the intelligentia of the dyestuff industry—the best trained, most progressive element in the field of textile chemistry. Men of this type owe a duty to the industry. They must *preach* progress as well as *practise* it. There is probably no individual who reads these words who cannot, without reflection, cite numerous instances where in recent years scientific development has made it possible to save costs or improve products—making sure of results and eliminating elements of uncertainty.

In the field of apparatus alone we might mention such developments as the use of non-corrosive materials of various kinds, the employment of time and temperature control apparatus, improved filters and water-softening devices, laboratory equipment of all kinds—such as improved lights, improved lamps for testing, photomicrographic devices—and so on almost without end.

Many mills are still reluctant to employ modern methods and devices of this character because of the initial expense involved. It has, however, been demonstrated to the complete satisfaction of those progressive concerns which make every effort to keep abreast of the times that the initial cost of these modern devices in the industry is soon written off through the production of superior products, the saving of labor, the elimination of "seconds," and other similar factors.

It must be borne in mind that those manufacturers of equipment who bear the cost of the research necessary to develop improved processes and apparatus will prosper only in proportion as their efforts are appreciated and their processes or products adopted by the textile industry. In so far as they prosper it will be possible for them to employ their profits in further development, hence it is incumbent upon the progressive element among the textile-chemical fraternity to encourage the adoption of improved methods and apparatus by their associates and their competitors, as well as by their own mills.

DYESTUFF RESEARCH

IN the 1922 Census of Coal-Tar Products recently published by the Government, and which was discussed at some length in our last issue, there appeared tables of the principal non-competitive colors—in other words, colors which have not as yet been satisfactorily produced in this country. Toward the prompt production of these "missing links" the American dyestuff manufacturer must bend his every effort. Viewed in the light of its effect upon the American industry in years to come, the initial cost of the research and equipment necessary to produce these products is not a serious item. It will unquestionably be offset by the increased confidence of the consumer in the American industry and the effectual prevention of a re-establishment of German dominance in our domestic markets.

The American dyestuff manufacturing industry cannot hope to maintain itself in the markets of this country and the world at large until it is entirely independent of all foreign competition and actually creative of unique products arising from its own research and enterprise.

The industry has been protected and by its accomplishments has unquestionably justified such protection. All credit is due the American chemists for the progress made in so short a time. But it is no time to rest. The present situation in the Ruhr gives temporary freedom from intensive competition, the importance of which can-

not be overestimated. Let this opportunity be not neglected—it is not likely to recur. When once again the German dyestuff manufacturers are in a position to resume their full-scale production let them find that America has not only duplicated their every success but has set new standards for them to strive to meet.

AMERICAN DYESTUFF NOMENCLATURE RECOMMENDED

SIR:

No one doubts that the technical and trade papers covering the American chemical industry favor its upbuilding. I therefore feel at liberty to point out to our technical writers who discourse on dyestuffs that should they use the nomenclature of the American dyestuff manufacturers their articles might be more in harmony with the commendable attitude of the trade journals in which they are published.

Some of the American firms have adopted distinctive names for their dyes, instead of adopting one of the names used for their prototypes in the Schultz tables. These American names have quite naturally become well known in many instances; in fact, it is a fault of the firms in this country if the names of their dyes are not quite familiar to our color chemists, as they have been supplying over 90 per cent of the dyes used here for the past seven or eight years.

One disadvantage suffered by the American concerns is that there is no standard work available containing their names, or associating their dyes with their well-known prototypes; it is a reasonable assumption, however, that anyone preparing an article for the press might obtain a list of each manufacturer's dyes, with their prototypes or Schultz numbers, as this information, in abridged form, is published annually by the U. S. Tariff Commission.

No one will deny that the use of the American names of the colors discussed in our technical papers, without favoring the products of any one firm, would properly promote the welfare of the industry in this country, and I am sure such a course on the part of our dye application chemists would meet general approval.

Very truly yours,

CHARLES H. STONE.

Textile Exposition Sets New Mark in Excellence and Attendance---Dyestuffs and Chemical Houses Among Exhibitors

THE International Textile Exposition and National Power Show, held at Mechanics Hall, Boston, the week of October 29 to November 3, exceeded the greatest expectations of its promoters in the excellence and variety of its exhibits and the numbers and enthusiasm of its visitors. More than three hundred different exhibits were shown, covering practically every phase of textile production from raw stock to finished fabric.

From the standpoint of the dyestuff industry the show was a marked success. The REPORTER has often asserted in its editorial columns that textile expositions constituted a type of educational and business stimulating endeavor which eminently justified the fullest co-operation of the dyestuff and allied interests. The present exposition unquestionably demonstrated the soundness of this contention. More mill men interested in dyestuffs and other textile chemicals were seen about Mechanics Hall in any one day of last week than it would have been possible to observe in a week at any other place or places of which we have knowledge.

Inasmuch as The REPORTER is concerned only with the chemical processing of textiles, no effort will be made to describe the remarkable exhibits of complicated machinery or the amazing displays of finished fabrics which were in evidence. Lack of individual mention does not imply an absence of appreciation of any exhibits.

Exhibitors whose products are associated with dyeing, bleaching and finishing operations we have covered briefly below. Our intention is merely to give an outline of each exhibit in order that those of our readers who were not able to attend the Exposition may have some idea of the number and nature of the exhibits shown.

Arabol Mfg. Co.
Amid-Duron Co.

Product samples of all Arabol sizing, finishing and softening compounds were shown. A particular feature was a demonstration of Amid-Duron, an emulsifier which when added to an emulsion has the effect of greatly increasing the evenness and minuteness of division of the oil particles and of stabilizing the emulsion so that it remains practically unchanged over long periods of time.

F. E. Atteaux & Co.

This was one of several brilliant and attractive dyestuff exhibits. A countless variety of materials dyed with this firm's colors was shown, including woolens

and worsteds in the piece, feathers, leather and art leather. Dyed skeins in rainbow arrangements were shown for three classes of colors—acid, direct, and developed. A very attractive new catalogue of the firm's products was distributed.

Bachmeier & Co.

A tastefully arranged exhibit showing a wide variety of skeins, hosiery, feathers, colored candles and other products dyed with colors handled by this concern. Only the familiar reproduction of "Dr. Baco" with his satchel was missing.

Borne, Scrymser & Co.

Samples of the wide range of textile oils manufactured by this firm, together with goods processed therewith, were shown. Special emphasis was laid on Breton Oil for wool and Breton Minerol for cotton.

John Campbell & Co.

This company displayed a wide range of colors for use on raw stock which are fast to fulling and dyed in combinations to match the latest seasonal shades. A new addition to their line is a very bright series of Monochrome (Chromate) colors.

Chemical Company of America

A huge blackboard showing dyeings of various colors and samples of other coal-tar products connected by ribbons with their common intermediates and crudes—the purpose being primarily to illustrate the correlationship between dyes, pharmaceuticals and explosives. On a center pedestal was a bottle of lilac perfume and samples of Patent Blue, Acid Green and Brilliant Milling Blue, all of which are derived from the same intermediates.

Cooper-Hewitt Electric Co.

Special lamps for textile mill illumination were shown, as well as a Uviarc cabinet for testing dyed samples for fastness to light.

Dunker & Perkins Co.

This was one of the most colorful and brilliant of the dyestuff exhibits. The foreground was a gilded arch, through which could be seen, draped over a brass rail at the back, a profusion of artificial silk satins dyed with Noil and Peerless direct colors, for which this firm acts as New England selling agent. Surmounting this display was a draped effect of silk plush, cotton-backed piece goods centering in a large artist's palette. Showcases on either side held a quantity of piece goods, skeins, hosiery, etc., dyed with colors exclusively handled in New England by the Dunker & Perkins Company.

E. I. du Pont de Nemours & Co.

The twelve-sided truncated cone with removable panels, which has previously been used by this concern for exhibition purposes, formed the center of this display. The panels showed ginghams dyed with Ponsol vat colors similar to those shown in the last issue of The Reporter, also examples of colored towels and table linens whose colors were guaranteed fast by their makers. A supplementary exhibit consisted of a washing machine in operation in which gingham dresses were being laundered and, after ironing, exhibited side by side with unlaundered garments. Fifty or more washings seemed actually to have heightened the colors.

J. B. Ford Co.

A wide variety of skeins, yarn, slubbing, blankets, toweling, hosiery, velvets, etc., from various mills, in the processing of which Ford textile soda products were used, was shown.

Hussong Dyeing Machine Co.

This exhibit consisted of a late model Hussong machine showing particularly the new enclosed chain drive from motor attached to the kettle. An automatic stop and reverse switch is within easy reach of the operator's hand. Folders were distributed illustrating the new removable double top for the cage, by means of which the entire top of cage is thrown open, and which, at the same time, forms a water-tight cover for the kettle when clamped into position.

The International Nickel Co.

The background of this booth consisted of large polished sheets of Monel metal and an innumerable variety of utensils and apparatus made of Monel metal was shown in the foreground. One interesting feature was a large wooden tank lined with Monel metal by the Beckley Perforating Company, which is designed as a gift to the Lowell Textile School. Literature describing the noncorrosive characteristics of Monel metal was distributed.

Jennings & Co.

This was primarily a reception booth for the entertainment of customers, tastefully decorated with flowers and Oriental rugs. A limited array of skeins and piece goods dyed with products for which Jennings & Co. act as sales agents was shown.

Klauder-Weldon Dyeing Machine Co.

A spacious and handsomely furnished reception room for the greeting of customers was the setting for a small, highly polished, all Monel metal rotary hosiery dyeing machine. The machine, with all its parts, both tub and cage, made of Monel metal, highly polished, attracted much attention.

A. Klipstein & Co.

This was a very colorful display. Artificial daylight lamps were arranged so that their rays fell on a wide assortment of dyed skeins of wool, silk and cotton; also a particularly interesting showing of union colors on

skeins of wool and silk mixed yarn. Towelings, ginghams and a variety of knit goods dyed with Akco colors were shown, also special serge featuring Akco Acid Navy Blue B and ladies' coating featuring Akco Chrome Black EHK.

Mathieson Alkali Works

Samples of various soda products manufactured by this firm, particularly cylinders of liquid chlorine and liquid caustic soda. A handsome booklet describing Mathieson textile chemicals and their methods of application was distributed.

National Aniline & Chemical Co.

This booth was done with red walls and white woodwork, which produced a remarkably attractive effect. The center feature was a large upright display of various dyed and printed fabrics, surmounted by an aeroplane view of the Buffalo plant of this firm. The whole was covered by an immense sheet of plate glass; indirectly illuminated in such a way that there was a complete absence of glare. On either side of the central display was a pyramid of illuminated barrel heads, stenciled for various National dyes.

Oakley Chemical Co.

Skeins, piece goods and hosiery in the processing of which Oakite had been used were shown side by side with similar goods processed without Oakite. Superior whiteness, absence of odor and increased softness were evident in all cases.

Procter & Gamble Distributing Co.

Olive, palm and red oil soaps in bars and flakes were shown, as well as the famous ivory soap flakes which are being highly recommended for many textile purposes.

Proctor & Schwartz

This concern occupied a very large space in the basement, wherein were shown many examples of the textile machinery made by the Smith & Furbush division of this company. Two large "Proctor" driers were also on display.

Seydel Chemical Co.

This company employed a moving electric sign which continuously expounded the merits of "Sizol" and other sizing and finishing compounds manufactured by them.

C. J. Tagliabue Mfg. Co.

This exhibit showed a wide range of the automatic control and recording devices made by this firm, particular emphasis being laid on the Tag Time-temperature control instruments and recorders used in the series of tests described in the last issue of The Reporter.

Tolhurst Machine Works

Various types of Tolhurst extractors were shown, illustrating particularly the latest type of electric switch control by means of which the run can be automatically determined and the operator advised by signal when the run is complete.

Taylor Instrument Companies

A wide variety of automatic controlling and recording instruments was shown, particular emphasis being laid on time and temperature control apparatus for use on dye kettles and recording temperature instruments to be used in connection therewith.

Textile-Finishing Machinery Co.

This concern took a leaf from the book of the dyestuff exhibitors, and exhibited a large collection of finished products which had been bleached, dyed and finished in machines of their own manufacture. The collection included fabrics of all kinds in a great variety of styles and patterns.

Thermo-Electric Instrument Co.

This exhibit consisted of Freas electric conditioning ovens of various types used for determining the moisture content of yarns, fibers and finished goods.

Zinsser & Co.

This exhibit featured Alizarine fast colors on skeins and piece goods. A new color for uniform cloth, Alizarine Blue Paste, Indigo shade, dyed chrome bottom, was shown. This is a straight color which produces a remarkably full and brilliant shade which is fast to all mill processes. Many beautiful Worumbo fabrics dyed with Zinsser Alizarines were shown.

American Consul-General Dumont at Frankfort, in a report to the Department of Commerce, writes the following paragraph:

"There is a demand for German dyestuff intermediates by the Russian aniline trust. Germans, however, are reluctant to sell such goods to Russia. Before the war they were exported to that country in large quantities, but were then fully fabricated in Russia in factories belonging to Germans. Under the present changed conditions Germans prefer to sell fully fabricated aniline dyestuffs."

W. J. Thorn, of Innis, Speiden & Co., will be awarded the prize for the best answers to questions prepared by Dr. S. F. Havens at a meeting of the Chemical Club of Philadelphia on November 5. P. S. Tilden, donor, will make the award, which followed the club's course on "Practical Chemistry for Chemical Salesmen."

Italian Dyestuff Market and Industry

Genoa, October 14, 1923.
Special to The Reporter.

ALTHOUGH the number of failures in the industrial firms has greatly increased this year, financial conditions in Italy have shown a marked improvement; this is indicated by the number of new limited companies—104 in January, with a capital of 41,701,000 lire; 127 in February, with a capital of 48,854,000 lire; 152 in March, with a capital of 102,075,000 lire; 132 in April, with a capital of 80,054,500 lire; 113 in May, with a capital of 73,324,000 lire; 157 in June, with a capital of 94,387,750 lire; 111 in July, with a capital of 47,741,000 lire; 171 in August, with a capital of 319,255,700 lire, and 105 in September, with a capital of 77,047,200 lire.

Increased Price of Colors

As the amount of the aniline coloring matters imported from Germany is still very large, the Italian consumers have been somewhat upset through the news that the association of the large German works, in view of the scarcity of the raw materials, has nearly doubled the price of the sale of the same in gold marks. Despite the continued efforts of the Italian color works and the support given to the same by the Government, it has only been possible so far to produce few of the colors required by the national industry; nor can the war reparation products aid matters. For this reason Italian dyers foresee being obliged to raise their manufacturing expenses during the coming winter, although the still low consumption of colored goods, imposed by the lack of money, encourages little such a step. English and American exporters will certainly be in a position to benefit by the above conditions of affairs, especially in the case of some products.

Reduction of Capital

The retarded adoption of protection customs in Italy, the competition of the colors delivered by Germany on private account of war reparation, and the difficulty of lasting and rational accords with the other Italian works, conjointly with the retard placed on the complete working of the new plants, if even the sales of the finished products were greater than those of passed years, presenting in every branch a very promising development, the benefits obtained during the financial year did not allow any divident to the shareholders of the firm "Fabbriche Italiane Materie Coloranti Bonelli," which decided to reduce the social capital to one-half, bringing it from thirty million lire to fifteen million.

Demand for Coloring Matters

The demand for coloring matters during the past five weeks centered as usual upon war reparation products and upon coloring matters imported through private commerce, such as Acid Blues, Acid Blacks, Fast Cotton Scarlets, Congo Red, Direct Cutch Brown, the Benzopurines, the Deltapurpurines, Azophosphine, the Sulphur Blacks, the Sulphur Blues, Diamine Catechine, Methyl Violet, Brilliant Green, Acid Magenta, Direct Orange Brown, Diazo Black BH, Chloramine Yellow, Cotton Sky Blues, Chloramine Yellows and Oranges, Primulin, Direct Bordeaux, Direct Violet, Steel Grays, Tartrazine, Direct Cutch Brown, the Ponceaux, Water Blues, Acid Navy Blues, Azofuchsine, Fast Milling Red, Amido Naphthol Blacks, Acid Violets, Acid Greens, the Sulphocyanines, Fast Milling Reds, Alizarine, Alizarine Blues, Alizarine Yellows, the Ericas, Indigo and other vat colors, Naphthylamine Blacks, Amido Naphthol Blacks, Eosine, Phloxine, the Rhodamines, Safranine, etc. The requests were distributed over the cotton, wool, silk, jute, artificial silk, paper, leather and ink industries.

Mordants, Assistants, Dyehouse Products

The demand for mordants, assistants and dyehouse products increased during the past six weeks. The strong oscillations of the foreign exchange, that brought the United States dollar from a value of 22.50 lire to a value of 21.30 lire and the English pound sterling from 104 lire to 98 lire, complicated business, acting often in favor of the Italian importers. The hope of a further regain in the value of the lira kept back, however, many from large purchases or from arranging big contracts. For this reason the market was overrun with many orders for comparatively small quantities. The German case brought little difference owing to the large stocks of their products already available in the peninsula.

Private Dyehouse Quotations

Some private quotations for dyestuffs at Genoa were as follows per kilo, showing how these competed against the reparation products: Direct Black, 32 to 35 lire; Nigrosine Crystals, 26 to 30 lire; Chrome Black in powder, 34.50 to 36 lire; Direct Green, 45 to 50 lire; Eosine, 51 to 75 lire; Orange II, 22 to 26 lire; Methylene Blue, 75 to 90 lire; Liquid Fustic Extract, 8 to 8.50 lire; Logwood Extract, 8 to 8.50 lire; Hematine Crystals, 12 to 13 lire.

Business in mineral colors was a bit better during the past six weeks, although still limited through the reduced demand on the part of ship constructors, industry and commerce.

Prof. James W. McBain, of the University of Bristol, Bristol, England, who has been in this country for several months lecturing on colloids and their application to soap, sailed for home October 27 on the Adriatic. Prof. McBain was heard at Brown University, Clark University and at the Chemists' Club, New York City. A summary of his lectures appears on page 822 of this issue of The Reporter.

COLOR MATCHING ON PAPER

(*Continued from page* 803)

fiber produced in the paper mill itself would vary from day to day, according to the original condition of the stock and the effect of the processes through which it passes. Furthermore, the original color of the fibrous material is further influenced by the addition of other substances, such as rosin size, clay, etc.

There are two general methods in use at present for the matching of colors. The first is the cut-and-try method of adding a little of this color and a little of that to the stock in the beater, and pouring a little of the pulp on the edge of the Fourdrinier wire, and then drying it over one of the drying cylinders in order to match it in the dry state against the color of the sample which it is desired to reproduce. The second is a laboratory test in which the same kind and proportions of fiber and other materials as will be used in the paper are mixed up in a laboratory size beater and colored with the dyestuffs which will probably give the right effect. It is necessary to have standard solutions of the dyestuffs used and to keep an accurate record of the amount of each which is employed in the coloring of the sample. Test sheets are made from time to time from the material in the laboratory beater, dried and checked up for color by matching against the sample. Where circumstances permit, it is, of course, advisable to make the laboratory sample sheets from the stock which is being prepared in the mill beaters, but the complete laboratory preparation has the advantage of knowing beforehand pretty well what is required in the way of coloring material.

The method here suggested is hardly more than an idea, but it may give someone a start on an interesting problem. It is proposed to use a tintometer or other suitable color-measuring apparatus for determining the color value in terms of the three primary colors of the stock used, the sample to be matched and the dyestuffs to be employed. This would necessitate a color analysis and determination of the percentages of the three primary colors in each of the dyestuffs made up to a definite standard concentration as used in the mill, and also a determination in terms of the three colors of the sample to be matched; finally, the same determination of the stock in the beater. The principal point to be discovered is whether it is possible, after having registered the quantity of each of the three primary colors in the stock in the beater and in the sample to be matched, to estimate the amount of each of these colors that has to be supplied in the form of a dyestuff. To do this would necessitate the measurement, as we have said, of the proportion of the three primary colors in the dyestuffs used by the mill, and then from the quantity of each of these three colors needed to bring the stock in the beater up to the color of the sample, figure from this the amount of each of these dyestuffs necessary to give the total amount of each of the three primary colors; each dyestuff, of course, furnishing a part of one or more of the colors required.

It may be that all of this has already been tried and found wanting, but if any work has been done along this line the writer is not aware of its ever having appeared in print.

A Simplified Method of Applying the Ostwald Color Theory

Methods of Measuring the Colors—The Lambert Mirror—Use of Multiple Glass Plates—Use of Apparatus —Determining Supplementary Colors—Practical Example of Using the Mirror—Error in Measuring Unknown Colors—Use of Dark Mirror Base

By ISMAR GINSBERG, B.Sc., Chem. Eng.

IN a previous article by the author which appeared in a recent issue of The AMERICAN DYESTUFF REPORTER, the principles and the method of application of the Ostwald theory were described in detail. The Ostwald color theory affords a means of measuring and differentiating between colors, in which each color is considered to be composed of three separate ingredients, all adding up to 100 per cent. Thus each color may not have a white or black content in addition to the pure color tone. The pure color tones are arranged around a circle in the order in which they appear in the spectrum of light to make one hundred different colors, each bearing a number starting at 00 for yellow and ending with 99. In this arrangement of colors, all containing no black or white but just 100 per cent pure color, yellow, red, blue, etc., colors separated by 50 units or found at the ends of diameters are supplementary, that is, when optically mixed, they will yield a gray. The grays themselves, mixtures of standard white and black of hundred per cent and zero per cent light reflection respectively,

are divided up into a series of one hundred colors, known as the dull colors. The colors, that contain one of the colors of the color circle in their composition, are known as bright colors; when they contain black, they are called dull-bright colors; those containing white, the clear-white colors and those containing both white and black, the turbid colors.

Methods of Measuring the Colors

The value of the Ostwald color theory depends primarily on the ease of its application in the ordinary color laboratory. That the Ostwald color theory is a very desirable method of identifying colors by mathematical process as well as determining the change that might take place in them due to the action of light, washing, chemicals, etc., resulting in the breaking down of the color and the formation of black or white, does not need any argument. In fact, there have been many investigations and reports, which have appeared since the Ostwald color theory was first introduced and recommended for practical use, in which the measurements of the colors were expressed in Ostwald terms. These articles refer, of course, to German investigations, as the theory has, as far as is known, not been used in this country in a practical way. There does not seem to be any lack of interest in the new color system in this country, but the difficulty has been to secure the apparatus and color charts used in its practical application. Ostwald recommends an optical instrument in which a pair of prisms used which does not appear to be very complicated as far as instruments go, at least not any more complicated than the ordinary spectroscope, but certain difficulties have arisen in making such an instrument which may still be unsolved. At any rate the purpose of this article is to describe how the Ostwald color theory can be applied through the aid of an instrument which is so simple that any chemist or laboratory worker can put it together without much trouble.

The Lambert Mirror

Probably one of the oldest optical instruments known is the Lambert mirror. Johann Heinrich Lambert lived in the eighteenth century and did considerable work along scientific lines in the measurement of light, pyrometry and hygrometry. The optical mirror, called by his name, is an arrangement for mixing together colors by optical means. In its simplest form the Lambert mirror is nothing more than a perfectly clear, smooth piece of plate glass, set at right angles to a horizontal plane, just a flat piece of board, which is grooved so as to hold the piece of glass firmly in an exactly vertical position. The position of the glass plate is arranged so that it is perpendicular to a window, in the room in which it is used, with the result that both sides of the supporting board are illuminated with equal intensity. Then if color cards of the same size are placed on either side of the glass plate, it is possible, when looking at the apparatus from the side, to distinguish two images, the image seen through the glass on the left, the posterior object, and the reflected image seen in the glass itself on the right, the anterior object. These two images may be made to coincide. The coincident image will then possess a color which will be an optical mixture of the two colors on the color card objects.

This is how Ostwald describes the use of the Lambert mirror, but there are certain difficulties connected with its use in this form. When the apparatus is tilted or the eye is held to one side or the other, a part of the reflected light is changed, as the quantity of this light is dependent on the angle of incidence. Ostwald mentions that the apparatus is improved by the use of a telescope, which is rotable about a base line drawn through the glass plate. Furthermore, a graduated arc scale can be employed to tell the angle at which the image is being observed, and the proportions of light emanating from both objects and combined in the common image. This simplified and improved apparatus can now be obtained from Janke & Kunkel, Cologne on the Rhine.

The Use of Multiple Glass Plates

Ostwald also mentions that the reflection of light can be materially increased by the use of several thin glass plates, one placed on top of the other. These plates should be made of glass that is as colorless as possible. This form of the apparatus is very simple to make and is claimed to give excellent results. The following is a description of how the apparatus can be put together.

In cases of necessity a single piece of colorless plate glass, four or five millimeters in thickness may be used. This piece of glass is placed on a dull black surface, such as dry plate photographic paper, blackened wood, wet slate, velvet, etc. According to H. Trillich in the Farben Zeitung, a piece of plate glass 4.5 centimeters thick with dimensions of 9 x 24 centimeters is used. Then, again, three dry plates 9 x 12 centimeters, made of almost colorless glass, were cleaned, polished and fastened with brass clamps to a plate holder to make a compound mirror. A fourth plate of glass was coated on one side with ivory black and an asphalt oil color. After this coating was dry, it formed a very excellent dark mirror. This was used as the under-surface on which the glass plates rested, and was found to be very satisfactory for this purpose.

A piece of wood 9 x 24 centimeters was used as the base board. The dark mirror was fastened to it. The board was nailed to supports, each ten millimeters high. In the middle of the board and at each side, two strips of wood about 15 centimeters high were nailed at a distance of five millimeters. The top ends of these wooden strips were bored and connected by a thumb screw arrangement, so that the supports could be brought closer together if necessary. The glass plates were held between these supports and the screw arrangement was

used to fasten them tightly together so that they were in a perfectly vertical position between the wooden uprights. A telescope arrangement was made out of a piece of cardboard, which was cut at a sharp angle and wound up into a tube in the manner of a mailing tube. The inside of the tube was covered with a piece of black paper and the outside appeared to the eye to be perfectly lightproof. This tube was 20 centimeters long and three centimeters wide. It can either be held in the hand or else fastened in a noose of iron wire, which is attached to the base board in such a manner that it can be rotated through a quarter of a circle. The position of the telescope with respect to the base line of the apparatus can thus be determined at any time.

Use of Apparatus

In using this apparatus, rectangular cards 3 x 6 centimeters, are employed as well as the regular Ostwald color cards 2 x 4 centimeters. The first step in the process is to place a white card in front of the plate mirror, formed of three glass plates which rests at right angles on a fourth plate, coated with a black film, serving as a background. Inasmuch as the background is black, the image of the white card is gray and the intensity of the gray varies in accordance with the angle at which the image is observed. Then for control purposes a white card is placed in back of the mirror. In this case the image is almost white instead of the expected gray. This bright grayish white similarly varies in accordance with the angle at which the telescope tube is held, so that at the sharpest angle of vision it appears almost a blackish gray.

Then another white card of equal whiteness as the first was also placed in front of the mirror. The reflected image then showed three grays. The middle image was the white of the card (white on white), on one side there was a lighter gray (black on white), and on the other side a darker gray (white on black). The grays again change according to the angle of vision and by bending the head or tilting the mirror, it is possible to find the angles at which the greatest and smallest differences between the grays occur.

Another unexpected color mixture was found to ensue when a green colored card was placed in front of the mirror. This appeared blackish green against the black mirror and scarcely any different than the original green against the white background. It is only when the white card was moved back over half the green card that the reflected image showed three color stages, the middle image being a whitish green or greenish white. The mixed image, green on black, was clearly greenish black in color and the mixed image black on white was, on the other hand, a clear madder light gray. The difference between the color images can be changed by altering the angle of vision. It is therefore evident that the gray was colored with a complementary color. This phenomenon can be demonstrated with any bright color in the Ostwald color circle.

Determining Supplementary Colors

The determination of the supplementary color can be carried out with the same arrangement of cards. The regular Ostwald color cards are used for this purpose. One of these cards, half covered up, can be placed in front of the mirror and another in back of the mirror. It is also possible to arrange two or three or four of them, one right alongside the other, in back of the mirror. It is also feasible to place them on a strip of cardboard or paste them on the same. It is now desired to find out which colors will give a neutral gray. It is indeed surprising to the investigator when he mixes together blue and yellow in this fashion and obtains a gray image in place of the greenish colored one that he expects to see.

It was found that when yellow 04 on the Ostwald scale was mixed with ulramarine blue 50 a pure grayish white, the neutral gray, was obtained. At this point it should be mentioned that Ostwald has made a change in his color circle. The colors have been shifted 02 part of the circumference. Thus where yellow occupied position 00 originally and ultramarine blue 50, they now occupy positions 02 and 52 respectively.

One difficulty with the use of the modified Lambert mirror for determining supplementary colors is that the the gray that is observed in the optically mixed color image cannot be compared with the standard gray that is used as a comparison color to tell whether or not two colors are supplementary, unless two standard gray cards are used, one being placed on either side of the mirror.

Practical Example of Using the Mirror

The use of the Lambert mirror may be better understood by considering a definite example of color analysis. Suppose a blue color is being examined for placement in the Ostwald color circle. The color has been printed or painted on a piece of white cardboard. The first essential detail is that the unknown color area on the white card be the same as that of the standard Ostwald color cards with which the unknown is to be compared to determine its exact supplementary color. This can be readily taken care of by trimming the card with a pair of scissors until a color card of exactly the same dimensions as the standard cards is obtained. Then the unknown color card is placed on one side of the mirror and the standard color card on the other side. It is possible to use a strip of standard color cards, mounted on a suitable background, so that one color after the other on that strip can be examined in conjunction with the unknown color. Only that standard color which is being optically mixed with the unknown color must be visible at the time of examination, the other colors on the standard color card being hidden in some suitable manner. Then there are arranged alongside both the unknown color card and the standard color, a standard neutral gray color card of exactly the same size as the others. In other words, there will be four color cards in all on

the base of the instrument, two on each side of the mirror. As has been mentioned above, in the modified Lambert instrument, a telescope tube is provided which has the effect of limiting and therefore concentrating the field of vision. The position of the telescope is manipulated until the combined image of the unknown color card and the standard color card is clearly visible. There will also be seen an image of the standard gray card. The combined image of the two bright colors will be grayish in color and this gray will correspond exactly to the gray of the standard gray card, when the proper standard color—in this case a yellow—is exactly supplementary to the unknown blue color. Thus if the yellow color, thus determined, occupies position 06 in the color circle, the position of the unknown blue color will be found to be 56.

Actual tests made with the instrument described above revealed the following pairs of supplementary colors, yellow 04 and blue 50 to 52, yellow 08 and blue 63, red 25 and green 75, red 29 and green 77, violet 38 and green 83. The slight discrepancies which are noticed in the above pairs of supplementary colors, that is that they are not separated by 50 Ostwald units in each case, is due to the experimental error in using the instrument. This error is not, however, any greater than that incurred by using the more complicated Pomi instrument with the compound prism arrangement, described in a former article on this subject.

Error in Measuring Unknown Colors

However, it is a fact that the error incurred in measuring certain unknown colors by means of the Lambert mirror is somewhat greater than that with the prism instrument. It was found in the case of a certain steel blue that the position of the same, determined in four trials by means of the corresponding yellow supplementary colors, was fixed once at 46, then at 47 and twice at 48. In measuring other colors differences of four to seven places in the color circle were established. Experience has shown that the color of the glass used in making the mirror has an important effect on the accuracy of the color measurement. This is particularly noticeable when measuring reds, for the glass generally has a greenish cast. If absolutely colorless glass, such as is used in making lenses is employed, there should not be any greater error in the use of this instrument than in the use of the prism apparatus. In other words this seems to indicate that the method itself is accurate enough and that there is not great difficulty experienced in employing this instrument in the measurement of colors with the proper degree of accuracy. The fault in construction due to the color in the glass can be readily mended by using a better quality of glass.

The Use of a Dark Mirror Base

The use of a glass plate with a blackened back as the base of the instrument gives rise to a number of interesting reflected images which are seen in the same and through the parallel sheets of glass which are combined together to form the Lambert mirror. As is known, two reflected images are seen through the mirror. These images seem to be separated by a distance equal to the thickness of the glass plate. When a number of sheets of glass are combined to form a single mirror, there are as many double images as there are glass plates. When a single plate is used, the reflected image of a white card placed in front of the mirror then appears like a piece of gray lines. It has a silver gray surface and on both sides there are narrow strips which are colored in different shades of gray and other colors in accordance with the angle of vision. When this angle is very sharp, then the posterior strip of color is a grayish black, the anterior strip a purplish gray and apparently narrower than the other. On closer observation it is seen that this light purplish gray band of color hides a stiller brighter one.

When the angle of vision becomes still sharper, four different shades of gray are seen in the dark mirror, each one a little dimmer than the next and the whole appearing as if three or four books had been placed on the other. At a certain angle of vision the entire picture is reversed and the mirror images change places with the reflected images. The edges of the images are tinged with the colors of the spectrum, indicating that the light has been refracted, as if it has been passed through a prism.

According to the investigator who has used the Lambert mirror, made in the form described above, the apparatus is recommended to all who are concerned with color measurement. It is easy to learn the manipulation of the same and colors can be measured and their position established in the color circle with ease by the average laboratory worker. There is not special technic to master. Those who are interested in the phenomenon of reflection of images and the optical mixing of such reflected images to give various colored mixtures in accordance with the color of the original objects will also find this form of the Lambert mirror of great interest. As has been mentioned above, it is possible to purchase the instrument by sending to Germany, if it is not wished to make it from parts that can be bought in this country.

E. I. du Pont de Nemours & Co. announce the production of Sulphogene Carbon 2B Conc. It is placed on the market in order to meet the demands of the trade for a particularly bluish shade of Sulphur Black. This product is very distinctive in its shade and has a tone of very desirable brilliancy. It is especially recommended for the dyeing of mercerized cotton yarn and cotton plushes. It levels very well and, because of this feature, is suitable for the various types of dyeing machines. Its solubility permits of its use in dyeing hosiery, warps, pieces, etc. Du Pont is also offering in a highly concentrated form Pontamine Red 12B Conc. This color has good fastness to washing, ammonia, acetic acid, rubbing and ironing.

Notes on the Dyeing of Direct Blacks on Cotton Piece Goods

Part X

By RAFFAELE SANSONE

Simplification of Plant

THE plant indicated in a preceding portion of this article gives very good results in practice. It, however, possesses the disadvantage of representing a very strong investment of capital, especially for those who are at present starting new printworks. In such cases a more simple form of plant could be adopted, that has all portions so concentrated that the different phases of the printing, drying, dyeing, fixing, and finishing can be conducted together as much as possible and within a limited space.

For reaching the scope a plant constructed on the principle shown in *Figure* 1 would offer great advantage, although based on a thoroughly new principle, not generally known to printers and dyers.

This shows a high iron case, divided, through special partitions, into three large compartments (A, B, C), the first of which surmounts a several color printing machine (P), having the usual blanket and backcloth; the last being dried in a portion of compartment (A) (indicated by a), whereas the other portion (b) serves for the drying of the printed material. Compartment (A) is heated by hot air produced in a small apparatus placed at the back of the plant.

The backcloth is dried by passing several times up and down in portion (a), and makes it way downward for being rolled on a wooden beam (r), placed on the outside. The printed material (m) enters in compartment (A) always with its unprinted portion against special guiding rollers that conduct it round and round in the hot air until reaching a central portion, from where it returns on the road precedingly followed, with the printed portion, however, against the guiding rollers; and makes its way into the second compartment (B), through a pair of entrance rollers (g), so arranged as to avoid the passage of the steam used in this compartment for the aging operations.

Here the patterned cotton cloth goods are carried many times up and down on a double series of copper or glass guiding rollers, and make their way through another pair of rollers (h), entering into the last compartment (C) of the case. This is divided into three portions; (c), in which the printed and steamed material is dried; (d), where it is repeatedly dried after its passage in weak dye baths contained in a long enameled iron or wooden vat (V) placed just below, having seven compartments where special guiding rollers can be lifted or lowered altogether, or one by one through a special arrangement.

In the third portion of compartment (C), indicated by

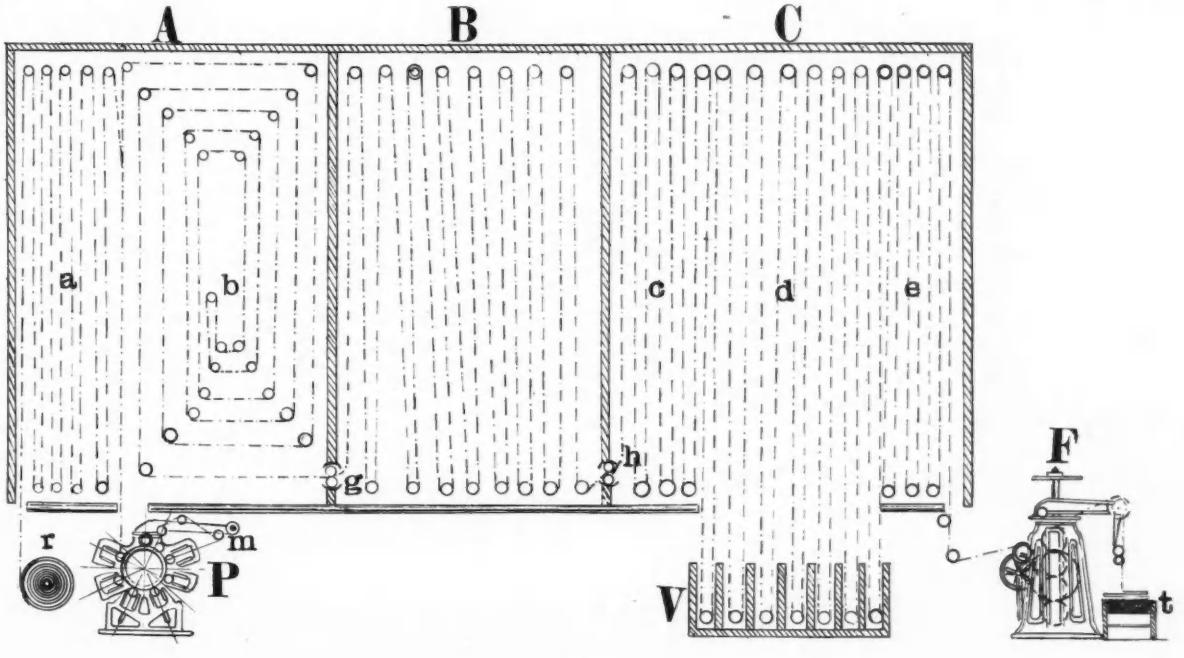


Fig. 1

(e), the cloth is given a final drying, and makes its way downwards for passing to the finishing calender (F), that imparts to it a dull smooth finish, a bright shreiner finish, a simple shiny polish, etc., as may be required by the different clients. It is then delivered onto a small wooden table (t).

The Working of the Plant

The task of the operatives in the above case would be much more simple than on any other plant conducting the same amount of work in another manner, and would be more or less as follows: These pass a strong piece of waste cotton cloth through the three compartments (A, B, C), or, in place of cotton cloth, simply a cotton or hemp tape, taking the precaution to enter the beginning of this also in the printing machine (P), where, however, the engraved rollers are moved so as not to press the central drum until the cotton cloth goods to be colored have initiated their entrance. The guiding rollers in the coloring vat (V) are now lifted and the bowls of the finishing calender (F) are distanced for a small interval.

When this has been accomplished the printing pastes, that are to produce the colored designs on one side of the cotton material, are prepared and entered in the corresponding color boxes, and the weak dye bath to serve for the coloring-over operations is introduced into the several compartments of vat (V), and move slowly through this so as to keep them always filled.

After the above operation the motor that drives the entire plant is placed in movement, approaching the engraved rollers of printing machine (P), lowering each guiding roller in the dyeing liquids just as the printed goods make their entrance in each compartment of vat (V), and approaching the bowls of calender (F) when these enter on it.

Through the above arrangement, or through the employment of any usual machine, the cotton cloth goods are printed in the usual way, and on mounting in (A) are separated from the backcloth used for preventing the smudging or dirtying of the blanket working immediately below, against the central drum or pressure bowl; and later make their way out of the case, to be rolled on beam (r), ready for re-employment on the printing machine whenever required.

In the meanwhile, in the other portion of (A) the printed cotton cloth is submitted to the action of the hot air for drying all printed portions and preparing them for the following fixing operations, after passing through rollers (g).

The steaming operations are conducted in this instance through the use of steam heated between 102 and 106 deg. Cent. through its passage in a special apparatus for being submitted to the action of hot air under a certain pressure. The cloth is thus treated with a mixture of hot air and steam, allowing the fixation of most colors within the shortest time possible.

In the last compartment (C) the steamed cloth, after being dried in the first portion (c), descends into the first division of the coloring vat (V), where it is impregnated in the cold or warm weak solution of the direct black, or a mixture of this with other direct colors, being then nearly completely dried when mounting in the second portion of compartment (C).

The cloth then makes its way into the second division of vat (V), taking up a small portion coloring matter solution with the color already fixed, and is again dried. The impregnation and drying operations are repeated until the material initiates entrance into the third portion of compartment (C), where it is completely dried, and descends in a printed and dyed condition, ready for passing through the calender (F) placed just below.

Advantages of the Plant

The advantages of the plant mentioned above are well worth considering for the following reasons:

1. The employment of labor, steam, motive power, time, space, and dyestuffs is brought down to lower limits than can be reached with any of the present plants.

2. The shade or color produced as ground can be changed whenever required by introducing at the end of the last piece being printed, before this has entered machine (P), a waste piece of cotton cloth, and distancing the engraved rollers as this waste piece passes into the second part of compartment (A), and the rollers in vat (V), as it passes into the seven compartments.

3. Through the use of the mixture of hot air under pressure and steam, superheated steam is formed, the temperature of which can be regulated at will, greatly facilitating the fixation of certain printing colors.

4. The backcloth, being dried at once, cannot accumulate dirt and can be employed over and over again.

5. If the department of the print works, where the production of the prints or treatment of the goods is conducted, is sufficiently high, the whole can be placed on the same landing; the workpeople then have access to its upper portions through a light iron or wooden stairs and platform.

6. Through special windows, placed at the front and back of the three compartments (A, B, C), the operatives can observe how the treatment of the goods is being conducted inside the compartments, performing in time any spreading operations that may be necessary, because of a wrong juncture of two pieces, or through other reasons, etc., etc.

Direct Blacks as a Ground to be Discharged

Some direct blacks have found a very wide employment as a ground in calico printing, where their easy dischargeability and cheapness have made many prefer them in other coloring matters, that may be faster, but require more difficult or complicated application. In this case some care is necessary in the choice of the discharg-

ing recipes and coloring matters to be discharged, as it is not only necessary to obtain the best results, but also to bring down as much as possible the cost of treatment.

The first problem to be decided in this case by the manufacturer and printer is the nature of the discharging pastes to be prepared. For the purpose there are at present quite a series of pastes at disposal, based on the use of zinc dust, tin salts, hydrosulphite of soda, etc.

The Zinc Powder Discharge Pastes

Zinc dust is the most powerful discharging agent, and although it is used regularly in some establishments for silk printing, with good effect, it is rarely, if at all, employed by the cotton printers. As a rule it yields a very good white, but has the disadvantage of filling up the lines or designs of the engraving, and as it consequently causes trouble it is not generally liked. Some printers assert, however, that they have no difficulty whatever with zinc dust discharging pastes, and they recommend as a precaution that the zinc dust be well ground with glycerine in a mill to make it into the form of an impalpable powder, which is passed through a very fine sieve for freeing it from grit or larger portions.

A recipe for a white zinc dust discharge is as follows:

200 parts of zinc dust,
240 parts of a suitable gum thickening (1:1) and
40 parts of glycerine are ground in a mill for a few hours, sieving and then adding
40 parts of ammonia and
80 parts of bisulphite of soda at 38 deg. Baume.

The above paste is printed on the cotton fabrics, dyed in suitable direct blacks, or mixtures of these with other dischargeable direct coloring matters, being then dried, steamed from one-half to three-quarters of an hour, and washed and dried.

A Colored Zinc Dust Discharge Paste

40 parts of a suitable dyestuff are dissolved in
120 parts of boiling water and
950 parts of gum thickening 1:1. To the resulting mixture are then added, with the necessary precautions
600 parts of zinc dust and
300 parts of sodium bisulphite at 38 deg. Baume.

The Tin Salts Discharge Pastes

Tin salts, and especially tin acetate, has found a much larger application than zinc powder for the discharging of cotton fabrics dyed in direct coloring matters. The last salt, however, often causes the whites obtained through its means to assume an unpleasant yellowish tinge. To remedy this defect the employment of an alkaline tin discharge or of a prussiate of tin discharge has been recommended.

The alkaline tin discharge has been prepared as follows:

600 parts of wheat starch and
1,600 parts of dextrine are warmed with
600 parts of water, and to the resulting paste are added
3,600 parts of stannous hydrate paste, boiling and adding
1,100 parts of sal ammoniac; the bath being then agitated until cold. At this point
1,300 parts of tartrate of ammonia are added that have been precedingly mixed with
1,200 parts of tragacanth water at 10 per cent.

The tartrate of ammonia is prepared by dissolving
5,000 parts of tartaric acid in
5,000 parts of water and neutralizing with ammonia until the reaction is slightly alkaline.

The prussiate of tin discharge is prepared by boiling together:

2,550 parts of acetate of tin at 18 deg. Baume,
300 parts of starch and
1,100 parts of dextrine, adding after this
2,200 parts of tin crystals and
300 parts of tartaric acid crystals or powder.

While the above is being conducted the color mixer dissolves in a separate vessel:

900 parts of yellow prussiate of soda in
750 parts of water, adding to the resulting solution
2,000 parts of gum solution 1:1. Both baths are mixed when cold. Either of the above tin discharges give better results and better whites than the tin acetate discharge.

The Hydrosulphite of Soda Discharge Pastes

Ever since their introduction the hydrosulphite of soda discharge pastes have found a very strong application in practice, owing to their greater simplicity, and to the possibility of finding them at all times on most markets in a stable and very convenient form. Besides this, when employed on cotton cloth and submitted to a long steaming, they do not weaken the cloth in any way; they leave no deposit in the engravings of the printing rollers; their printing pastes can be kept for some time before use; a better white is possible through their means, etc., etc.

A good white discharge is prepared in this instance as follows:

40 parts of wheat starch are made into a uniform and semi-transparent paste with
200 parts of water, and to this are added
160 parts of a 6½ per cent tragacanth solution and
5 parts of glycerine. To the resulting mixture when cold are next incorporated from
250 to 400 parts of hydrosulphite of soda, that have been previously dissolved in
200 parts of warm water.

The dyed cotton goods are printed with the above paste in the usual way, being dried and steamed with very hot and dry steam kept at a temperature between 102 and 105 deg. Cent.

A Colored Hydrosulphite Discharge Paste

A colored hydrosulphite of soda discharge paste often employed is as follows:

30 to 50 parts of a suitable basic coloring matter,
10 parts of wheat starch,
300 parts of gum water 1:1 and
50 parts of glycerine are warmed together with constant stirring for about one half hour, closing off the steam and continuing this until the bath is cold. To the cold mixture are then added
50 parts of fresh tannic acid dissolved in
50 parts of glycerine, adding after this
200 parts of hydrosulphite of soda dissolved in
250 parts of water. The printing paste is then ready for use.

Choosing the Coloring Matters

The choice of the most suitable coloring matters for the reproduction of a given pattern and ground requires some study, and certain experimentation in the laboratory is often necessary, as this reproduction can only be accomplished in exceptional cases, with a single black, and generally requires two or more blacks, with or without other shading colors, all of which have to be dischargeable. For this reason the dyer often needs, besides his range of blacks, a certain number of dischargeable blues, reds, yellows, browns, greens, violets, etc.

Operations of Treatment

When the above question has been decided it is necessary to ascertain how the different operations of treatment are to be conducted. These comprise:

1. The dyeing of the cotton fabrics in the direct black, or direct colors.
2. The drying of this and preparation for the printing operations.
3. The discharging or printing operations.
4. The second drying.
5. The steaming operations.
6. The third drying operations.
7. The chalking operations.
8. The fourth drying operations, or final drying operations.
9. The finishing operations, etc.

(*Continued on page* 818)

SCIENTIFIC WASHING

(*Continued from page* 796)

tures of soda ash and sodium bicarbonate. Such mixtures occur in nature. The natural product is known as "trona." A great deal of this natural product was used in powder laundries prior to the manufacture of a more refined material. In other words, the various alkali manufacturers who began the manufacture of the mineral known as "modified soda" merely duplicated something already provided by nature. With the exception of a higher degree of purity than the natural product possessed, no new properties were added.

Explaining "Modified"

The bicarbonate of soda exercises a retarding effect upon the hydrolysis of the soda ash when the compound is dissolved in water, with the result that the actual yield of alkali in the active form is very low. Stating this another way, it is not sound theory to assume that the amount of available alkali in modified soda is equivalent to the amount of soda ash which it contains, because the large proportion of CO_2 present, acting as an acid, prevents some of this alkali from becoming available. A valuable portion of alkali is lost outright through the action of the so-called "modifying" element.

The original object in offering the modified sodas to the laundry industry was to provide an alkaline detergent which was milder than soda ash—i. e., not as destructive to the fibers. However, the idea as worked out proved to be a case of "robbing Peter to pay Paul," for, to the extent that the bicarbonate reduced the destructive action of soda ash, the detergent value of the compound was sacrificed.

Moreover, it soon became apparent that much of the desired protective influence of the bicarbonate was lost through the effect of heat at washwheel temperatures. So, in the use of modified sodas a compromise is actually made between destructive action and efficiency, with the result that the manufacturers of these compounds are not safe in promising much in the way of either fiber protection or efficiency.

Making Bleach from Soda and Lime

In laundry practice the modified sodas are frequently substituted for soda ash in the preparation of soda bleach. About 2 pounds of modified soda will be required to replace 1 pound of soda ash.

The bleach liquor so prepared contains an excess of carbon dioxide gas (a weak acid), which tends to speed up the action of the bleach.

Bleach prepared from modified soda and bleaching powder is normally pink, and when soda ash is used the characteristic color is green. This difference in color is due to the action of the bicarbonate ion on the liquor, promoting oxidation of traces of manganese present as an impurity in the bleaching powder.

What Temperature Is Required to Decompose Soda

The use of soda is occasionally defended by the claim that the manufacturing process is such as to

guarantee control of the bicarbonate up to at least 200 deg. heat.

Bicarbonate, whether in combination with carbonate or alone, gradually loses carbon dioxide when its solution is heated to about 60 deg. Fahr. At boiling temperature the salt is entirely converted to soda ash. The liberation of gas can readily be seen by a simple experiment.

Procure a test tube whose mouth can be covered tightly with your thumb, or a bottle having a small neck. Put into it a teaspoonful of soda. Now fill the test tube or bottle nearly full of hot water at the temperature used in the suds. Hold your thumb over the mouth for a moment, then slowly open it and note the sudden expelling of gas. If a cork be placed snugly in the tube or bottle it will be forced out by the accumulation of gas as the heat decomposes the soda.

In looking through the solution fine bubbles of gas will be seen rising to the surface.

Another View

The average modified soda contains about 43 per cent bicarbonate. It is established by experiment and confirmed in the literature that only the soda ash is effective in water softening and in increasing the emulsifying powers of soap.

From this it follows that if the soda advocate claims his product does not decompose and form soda ash at the temperature of the load he should be consistent and admit that the approximate 43 per cent of his product is without value either in softening water or in increasing the emulsifying powers of soap.

Trisodium Phosphate ($Na_3PO_4 + 12H_2O$)

Trisodium phosphate, or "Trisodium" as it is commonly termed, has been used to some extent as a detergent alkali. In fact, it is a product which enjoys the high regard of many, though the reasons for this appear to be based on opinions rather than on real superiority on the part of trisodium.

The favorable attitude toward trisodium is probably due to its strong affinity for the hardening materials in water. Soap is thereby given a favorable condition for sudsing. In fact, a careful investigation of the properties of trisodium reveals the fact that its ability to soften water and prevent the formation of lime and iron soaps constitute its principal virtues. Of course, in plants using soft water its water-softening properties cannot be utilized (unless lime is introduced as a part of the bleach).

Trisodium contains about 55 per cent water. On a basis of alkali value (hydroxyl ions) it has about one-fourth the value of soda ash. Obviously its use as a source of available alkali will not prove economical.

Borax ($Na_2B_4C_7 + 10H_2O$)

Borax is a natural mineral which has been used to some extent as a source of "milk alkali" for wool and silk washing, and in some household soaps. When added to metal cleaning compounds, it has a slight retarding action on the tendency of iron to rust. As a textile detergent a very slight bleaching action is observed, but as a sole source of bleaching action borax cannot be economically used.

As a source of alkali in the hydroxyl ion form borax is even less effective than trisodium phosphate.

For these reasons borax is not used commercially as a detergent to any great extent.

Silicate of Soda (Na_2SiO_3)

A discussion on detergent alkalies would not be complete without consideration of this compound. Silicate of soda has been used for years in general household and laundry soaps. It is low priced and as a result its use in soap tends to lower the cost of the latter. Therefore, it is frequently regarded simply as a filler, without any recognition of the fact that it has detergent value of particular merit.

As a matter of fact, silicate yields a reasonable amount of active alkali, and it also belongs to the class of materials which exhibit colloidal properties. In consequence, it greatly assists in the removal of dirt, and there is no question but that the use of silicate of soda with soap *under proper conditions* greatly improves the detergent power of the latter. Moreover, there is less tendency for the work to turn yellow or gray as a result of the use of silicate.

Silicate exists as a thick, viscous liquid which is difficult to handle. This condition greatly restricts its purchase and use directly by laundry owners.

The detergent application of silicate has received considerable attention among scientific men in Europe and this interest is spreading to America.

BRITISH DYE INDUSTRY

Activity in the dye trade of England shows a noticeable increase for the first half of this year when contrasted with this same period for 1922.

A report to the Department of Commerce from the American Consulate General at London lists imports of intermediate coal tar products at about 112,000 pounds compared with only 100 pounds last year. Alizarine dye imports showed a decrease, while imports of synthetic indigo, of which none was imported during the first half of 1922, totaled over 800,000 pounds. Of the natural indigo, however, nearly 77,000 pounds was imported during the first six months of 1922 and 48,000 pounds for the same period of this year.

Exports of dyes aggregated over 7,000,000 pounds, nearly twice the quantity for the first half of the previous year.

NOTES ON THE DYEING OF DIRECT BLACKS ON COTTON PIECE GOODS

(*Continued from page* 816)

The Dyeing of the Fabrics

The dyeing operations required with the above class of printed cotton goods are conducted very often on the jigger, as the machine is to be found in nearly every print works. Besides this, the quantity of each article to be printed is sometimes not very large. Other machines sometimes employed are the beam dyeing machine and the continuous dyeing machine.

A form of continuous dyeing machine used in France is shown in *Figure* 2.

This is constituted of a strong, light, painted iron frame (H), fitted in solid cement (b, b), and sustaining four conically shaped enameled ivon vats (D, C, B, A), that are supplied on their rounded bottoms with the corresponding number of openings (o, o, o, o) for the running off of all dye baths or rinsing waters, and that, by a special arrangement, are opened or closed from above with a small chain (c), fixed to the top of each vat. The bottoms of such vats contain a pair of guiding rollers (s).

At a certain height above these is placed a second series of guiding rollers, indicated by (r), on which the cloth is raised to a certain height above the vats of treatment; whereas, at their end is fixed in each case a pair of squeezing rollers (S, R, Q, P), the lowest unit of which is driven by special pinion wheels (p, p, p, p), moved in their turn by means of a long iron shaft, other large pinion wheels and a fixed and loose pulley (U).

The four baths of treatment are heated, in this instance, through a short closed copper coil, placed on the bottom of each vat, and to which the steam is introduced by taps on a long unique iron tube (T); all excess of steam, with any condensed water formed, is led out by another tap, also leading to a unique discharge tube, and placed just below the first.

The cloth is led into the plant from a wooden beam (E), following the direction shown by the arrow, and enters on the first upper guiding roller, passing then slowly through the different dye baths and squeezing rollers, for making its exit later on the roller (n), and is rolled on another beam (F). The hole (o) below each vat leads, through a special arrangement in the basements below the plant, to a canal (m), that can be made to lead the discharged baths either to the waste water main or to storage tanks, if it be necessary to eliminate waste liquors, or to collect old or consumed dye baths.

The working of the above plant is conducted in some establishments under certain rules. One of the first operations, when initiating dyeing, is to pass a tape through the machine, so as to run on all upper and lower guiding rollers (r, r, r, r, r, r..... and s, s, s, s, s, s.....) in close succession, and through the nip of the squeeze rolls (S, R, Q, P) placed in between.

After this, the dye baths required for the treatment of the goods are introduced, turning on steam for bringing them to the boil. When this has been accomplished the operatives start the passage of the cotton fabrics to be colored, by causing the machine to move very slowly, and by controlling its driving by means of a small handle placed at the back of the plant. While doing this they spread them by hand before their entrance between the nip of each pair of squeezing rollers. A guard before the rollers prevents injury to the fingers of the operatives.

When the beginning of the cloth has thus been spread evenly throughout the whole plant, the treatment proceeds quite smoothly. From time to time the work people add to each bath a fixed volume of strengthening coloring matter solution to replace that taken up by the material running through. This is given, in the first dye bath (in vat D), a certain amount of color, and when it enters the second dye bath (in vat C) its shade is darkened considerably, the dyeing operations in the following vats (B and A) then completing the production of the desired shade.

(*Continued in next issue*)

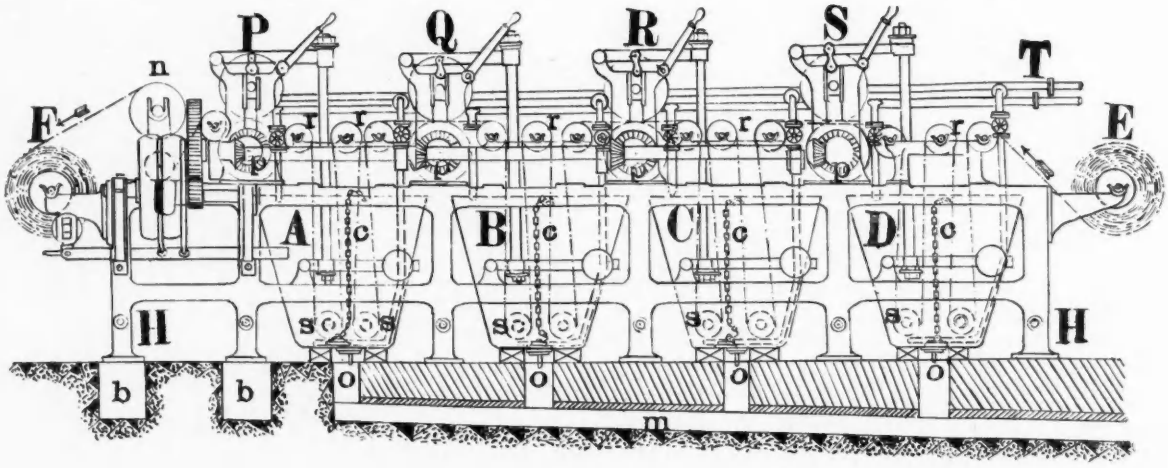


Fig. 2

400,000 POUNDS ANILINE COLORS TO CANADA

This no doubt constitutes a record as the greatest amount of dyestuff imported into Canada in one shipment. Included in this shipment was 100,000 pounds of Columbia Black EA Extra, a direct black which was well known to the trade previous to the war. This extremely large shipment comprises colors that are suitable for the dyeing of any known material, such as wool, cotton, silk, unions, leather, paper, feathers, etc., etc. These colors are manufactured by the Actien-Gesellschaft fur Anilin-Fabrikation, the Chemische Fabrik Griesheim Elektron, and Chemische Fabriken vorm. Weiler Ter-Meer.

SELF-DYEING OF THE SILK WORM

Different Colors Produced by Feeding the Cocoon

Paterson, N. J.—Whether or not silk can be dyed by feeding the worm in a certain way is a question being freely discussed here by the manufacturers of silk as well as dyers. It was said that the process was perfected by the Austin Silk Plantation Manufacturing Company, of Austin, Texas, about eight years ago, and samples of the silk dyed at that time show one of the purple and cerise tones. It is claimed by those interested in the growth of the worm in this way that silk is a natural color, produced by the worm, brought about by a secret process.

The cocoons when cut open after experimenting with this process are the same color to the inside, and even the most skeptical admit that the natural colors produced in this way would be more practical for the silk as well as mixed fabrics. The color would be fast and not likely to fade. The variation of tones and colors produced in this way is as wide as dyed in the skein or piece goods, and should the method be generally adopted it would mean a big reversal in the methods of dyeing in this city, which practically controls the industry so far as silk is concerned, and dyers are immensely interested in the project.

Experiments have been in progress for the past eight years, and it is believed by manufacturers here that if this type of raw silk could be grown in Austin, Tex., it could be grown elsewhere in the country and be made not only a profitable business but save the silk industry of this country, and also keep the price of the product down to a normal basis, with fluctuations to be about the same as the changes in cotton.—Journal of Commerce.

The Summit Dyeing Company, Ltd., a branch of the firm of the same name of North Bergen, N. J., has purchased a plant in Toronton, Ont. Equipment is being installed, on which $100,000 is being spent, and alterations are being made in the plant. The company will specialize in the dyeing of artificial and natural silks.

The Cretona Print Works have been incorporated at Clifton, N. J., under the laws of New Jersey, to print and dye fabrics. The company will issue $30,000 of preferred and 300 shares of common stock, having no par value. Arthur S. Corbin is named as the incorporator.

The Textile Color Card Association of the United States, Inc., announces the removal of its offices to 50 East Forty-second Street, New York City, November 1, "where the door swings wide to welcome you always."

The Committee on Prize Essays of the American Chemical Society has announced the opening of the contest in which all students of high and secondary schools in the State of New York have been invited to compete. The prizes total $10,000 in cash and include many attractive scholarships to Yale, Vassar and other universities and colleges. This contest, the result of a gift of Mr. and Mrs. Francis P. Garvan, of New York, has been favorably indorsed by John J. Tigert, Commissioner of Education of the United States. The supervision of the contest has been put in charge of a committee composed of H. E. Howe, Dr. Wilder D. Bancroft, Dr. Charles H. Herty and Alexander Williams, Jr. Other committees will be chosen for judging the essays and awarding the prizes.

Henry B. Faver and R. Norris Shreve, who have for some years practised as chemical consultants, have formed the partnership of Faber & Shreve, with offices at 50 East Forty-first Street, New York City. They have done important work in the fields of filtration problems, development of markets for trade wastes, medicinal and photographic chemicals, dyes and intermediates, high explosives, research and pyrotechnics.

Cooper & Cooper, Inc., 23 Cliff Street, New York City, have been appointed local agents for the Delta Chemical & Iron Company, Wells, Mich. Stocks of Delta products, methanol, acetone, lime acetate, formaldehyde and acetone oils, will be carried by the agents for prompt delivery in this section.

THE ALLIED CHEMICAL AND DYE CORPORATION

A review of the present condition of the Allied Chemical & Dye Corporation, with favorable comments on the status of its subsidiary companies, appeared recently in the Magazine of Wall Street. The capital and securities of the organization indicate a strong financial position, and the outlook promises an average amount of business for 1924. While no boom is expected, the article states, there will be no drop in total gains for the year. The article says further:

"The Barrett Company has enjoyed very handsome earnings as a result of the great activity in the industry. While it is true that the building business has probably passed the peak, the outlook is sufficiently good at this time to assure fair earnings for the Barrett Company next year. An equally important factor in the affairs of Allied Chemical is the General Chemical Company, which has shown a substantial earning power for a long period of years.

"Another important unit of the parent company is the National Aniline & Chemical Company. Of course, this company is not in a position to make the large profits that it could make when foreign competition was shut out, but it has developed an efficient organization and many of its products continue to have a good market. German competition has been felt principally in certain special colors and in fast colors. The tariff places a duty on the finished products of 60 per cent of the American valuation, but despite this high duty the German product can, in many cases, undersell the domestic article.

"Semet-Solvay Company is the chief builder and operator of by-product coke ovens in the United States. Solvay Process Company is the largest manufacturer of alkali products, and operates by-product coke ovens. The by-product coke oven business has developed in the past decade as rapidly as any industry in the country, and the outlook is for continued growth."

The Department of Commerce, Bureau of the Census, recently issued two bulky statistical bulletins giving interesting figures on the chemical, textile and allied industries. These figures are the results of the 1919 Census of Manufactures, and therefore the latest available. The tables included in these bulletins show comparative summary of both industries for the census years 1899 to 1919, inclusive, with percentages of increase for each period, value of products by States, age classification of the number of average wage-earners and prevailing hours of labor, both by States; size of establishments by number of employees and by value of products, character of ownership, statistics of fuel consumed, etc. The bulletin on chemicals includes sections on Sulphuric, Nitric and Mixed Acids, Coal-Tar Products, Natural Dyestuffs and Extracts; the one on textiles, sections on Wool, Silk, Cotton and Knit Goods Manufactured, Scouring, Dyeing, Finishing, and various other branches of the textile industry in general.

GERMAN DYE INDUSTRY INERT

"The German monopoly of the world's dye production has been temporarily if not permanently broken," was quoted in the October 22 issue of The REPORTER as being from the 1922 Dye Census report. This statement is given greater weight by what Herman A. Metz says of the German industry. Mr. Metz recently returned from Germany.

Dye plants in that country, he says, are operating on part-time schedule; that colors being made are not wanted in America; that so far as the Germans are concerned, the American market is closed.

Raw materials, fuel and labor costs are so high in Germany that German dye plants cannot continue to operate long. Their export trade has been almost completely shut off by the 26 per cent French tax. What little business German dye men are doing is concentrated on the Far Eastern market. Even if this country had no tariff, Mr. Metz said, the American dye industry would be able to compete on most colors, regardless of German competition.

Possibly the greatest damage to the German chemical industry, Mr. Metz felt, was the halt which the present chaotic condition had called on research work. Many experiments already started had of necessity been dropped, and in this work he saw the German dye and chemical industry crippled for the future.

Recent Literature

Coal-Tar Colors in the Decorative Industries. By A. Clarke. 179 pp. Illustrations. D. Van Nostrand Co., New York, 1923. Price $2.00.

This little volume not only covers a subject which has been more or less partly treated by other writers in the same field, but it also serves as a handy and efficient guide to all phases of dyeing, testing and coal-tar colors in general. It includes an interesting historical introduction giving much information on the progress of coal-tar color production from its discovery to the present day. The following sections are devoted to: Dyes and Dyeing, Mordants, Lakes and Pigments, Wood, Paper and Leather Dyeing, Dyestuffs in Oil and Spirit Varnishes, and Miscellaneous Application of Coal-tar Colors. It makes a valuable book of reference because of its bibliography and formulæ included in its simply written text.

Production of Hydrosulphite Solution

By F. A. Eustus

Virginia Smelting Company, Boston

MOST of the larger users of hydrosulphite find it advantageous to produce a solution of hydrosulphite from day to day, or at least twice a week, as they require it. Many of the smaller users buy the dry hydrosulphite powder, sometimes called lykopon, to supply their requirements of chemical reducing agent, and there has been for some years more or less rivalry between the two procedures. During the last three years the price of the dry hydrosulphite powder has steadily been reduced from over a dollar a pound to 25 cents or less per pound. If during this time the practice of making hydrosulphite solution had not been improved the production of the solution at the mills would probably have ceased, but improvement in the manufacture of hydrosulphite has not been confined to the makers of dry powder.

The more progressive dyers in the textile mills, working in co-operation with one of the producers of liquid sulphur dioxide, have steadily improved this practice, until the cost at present in the larger mills for making the hydrosulphite solution has been hammered down to an equivalent of about 12 cents per pound of chemical dry powders.

Improvements in the practice of making the solution at the mills has been accomplished by improving the apparatus and the details of procedure. The time required to prepare a batch of 100 to 600 gallons has been reduced to an hour and a half. The amount of labor required now does not exceed two men for two hours to make the largest batch, and much of this time one man is sufficient.

The yield in finished solution has in some cases been 98 per cent of the possible yield from the chemicals used, and in any well-laid-out plant it should not fall below 90 per cent. Almost any concentration desired can be secured. Many of the mills make a finished solution of sodium hydrosulphite containing about a pound of sodium hydrosulphite per gallon. This can be pushed up to 1½ pounds per gallon, but the production of so concentrated a solution entails some loss.

Hydrosulphite solution cannot be kept indefinitely. If left unprotected in the dyehouse it will deteriorate in twenty-four hours. Improvements have, however, been made in the manner of keeping it. A patent has been granted to Peter McIntyre on an apparatus for this purpose, and many storage tanks made under his patent are in use. In such an apparatus the solution can easily be kept for forty-eight hours, and the deterioration in three days is relatively small.

The dry powders keep relatively well, but there is some deterioration even in the dry state. The hydrosulphite powder as received at the dyehouse generally contains useful sodium hydrosulphite to the amount of about 85 per cent of the weight of the powder. When the solution is made fresh there is, therefore, less foreign matter in it than when it is prepared by dissolving up the dry powder.

Where will the race between the dry powders and the solution end? Doubtless the efforts to improve both will continue. The makers of dry powders will always be confronted with the losses involved in desiccating them, and considering the nature of the chemical one would expect that these losses must always be considerable. Moreover, this desiccating operation is, of course, an item of expense. It is therefore hard to see how the cost of the dry product can ever be reduced as low as the cost of the solution. This applies particularly to straight sodium hydrosulphite.

Formaldehyde hydrosulphite, which is largely used in printing, is a more stable salt, and the process of desiccating it is easier. It is largely delivered in the dry form under the names of rongalite, formosol, etc. Some plants, however, make it in the form of solution as they need it. In the case of this salt the advantages of the solution seem less certain than in the case of the straight sodium hydrosulphite.

CHEMICAL INDUSTRIES CO-OPERATE WITH RED CROSS

The chemical manufacturing interests of New York City are co-operating actively with the Red Cross in its annual roll call, which opens Armistice Day, November 11, and continues until Thanksgiving, for the enlistment of new memberships to maintain the organization's manifold peace-time program of relief and public health work.

Samuel Fairchild, of Fairchild Bros. & Foster, heads as chairman a special chemical manufacturing group formed in accordance with the campaign plan of organizing the entire city into various industrial, mercantile and professional groups to facilitate the roll call effort. A special roll call committee of representative leaders in the chemical manufacturing interests will function under the chairmanship of Mr. Fairchild to secure the maximum response to the roll call throughout these interests, and plans are already under way to reach every person in the interests directly with the Red Cross appeal.

Help for the ex-service man and his family, including legal assistance, loans of money, advice on domestic matters and medical care; disaster relief, and a public health program are features of the work in New York for whose maintenance the annual roll call is conducted. The public health program includes the supplying of surgical dressings to twenty-two local hospitals, nursing service, first aid, and work in home hygiene and care of the sick.

MISTAKES IN COTTON BLEACHING

The causes of stains on bleached cotton pieces may be divided into two classes, such as made very distinct by sharply marked borders, and those, usually larger, which do not show up well before dyeing.

When the pieces are to be scoured after weaving, it is of great importance to see that they are packed properly, so that there are no open places, and the lye is forced to pass through every part of the goods. Stains may be caused by neglect of this precaution. They are brown in color. If not too dark, they can be removed by chloring and souring. It is obvious, however, that considerations of expense dictate that such stains must be prevented by proper packing. The scouring lye of caustic soda must be pumped warm on to the goods. If it is pumped cold, the parts of the fabric that it first touches are apt to be mercerized, and hence dyeing stains, or in other words, unlevel dyeing cannot be avoided, as the mercerized parts dye darker than the unmercerized parts.

Rosin stains may occur from unsaponified rosin in rosin soaps. Here prevention is the only cure; these stains are very difficult to deal with; in fact, their removal at any reasonable cost and without damage to the fiber is practically impossible.

When the scouring is finished, the goods must be quickly rinsed in the kier with cold water to prevent them drying on to the hot tins, whereby lime stains are caused.

Rust stains occur when the goods, still damp from the scouring, come into contact with iron. If they still contain lye, the fiber may be tendered by conversion into oxycellulose, as well as stained. The kier must, therefore, be frequently painted inside with a mixture of milk of lime and egg white. Rust stains can be removed with oxalic acid, and the goods must be very thoroughly rinsed after this treatment.

After scouring, the goods must be thoroughly rinsed.

Acid stains are caused by imperfect rinsing after scouring, especially if the goods are dried after the rinsing. They are irremediable if the fiber has been tendered, and in the case of cotton it nearly always is. Such stains, of course, never occur except through gross carelessness.

If goods which still contain free acid are soaped, the effect of the acid is neutralized, because the soaping comes quickly in the natural sequence of the operations, but another difficulty is introduced. The acid sets free fatty acids, which, when the goods are rinsed with ordinary water, form lime soaps, and these act as a reserve in dyeing.

Defective rinsing after bleaching with bleaching powder and souring with sulphuric acid leaves sulphate of lime on the fiber, which causes white stains, and cannot be removed once the goods are dry.

Strong lyes of bleaching powder may cause tendering by the formation of oxycellulose. This substance may also be produced from the fiber by prolonged action of sunlight or even of the air on goods soaked with much weaker bleaching powder lyes. Oxycellulose may also be formed if air is present in the kier, and made very active by the high temperature prevailing. The parts of the fiber which are converted into oxycellulose are permanently tendered, and there is no cure. They, of course, cause unlevel dyeing by the difference in affinity for dyes between the changed and the unchanged parts of the fabrics.—Posselt's Textile Journal.

Dispatches from the Berlin Bureau of the "Daily News Record" state that heavy shipments of German dyestuffs were lost as a result of the earthquake, and that the Tokyo offices of the Dye Cartel were destroyed.

The Study of Soap Solutions and Its Bearing Upon Colloid Chemistry

Sols and the Theory of Colloidal Electrolytes—Theoretical Consequences—Structure of Jellies—Properties of Soap Curds—Concentration of Soap in the Surface

By J. W. McBAIN, F.R.S.

Professor of Chemistry, University of Bristol, Bristol, England

[Editor's Note: The following treatise is a comprehensive summary by Prof. McBain of a series of lectures recently delivered by him at Brown University, and presents in concise form the theory and facts regarding soap solutions which constituted the basis of those lectures.]

THE study of soaps has so many ramifications and the phenomena met with are so manifold that it is only by exercise of the severest restriction that a clear general picture can be obtained. On the other hand, they lend themselves particularly to the study of the colloidal condition and its relation to other states. They are of known chemical composition, but constitute in themselves so numerous a family that almost any desired combination of properties can be obtained. Furthermore, they are typical of a very great group of ionizable materials and they exhibit a particularly close parallelism with the behavior of the salts of protein and gelatin.

The following study will deal chiefly with the properties of fluid solutions and clear transparent elastic jellies in the state of complete true reversible equilibrium. Brief mention only will be made of the common occurrence of soap in the form of white opaque curd, which is confined to sodium soaps, and of the fact that very many soap solutions afford particularly accessible examples of anisotropic liquids. Thus, in this review no mention will be made of our studies of unstable systems and time effects, nor of our studies on the effects of salt and salting out, the soap-boiling processes, surface phenomena, the hydration of curd fibers or detergent and protective action.

It will clear the ground to state that dilute soap solutions are ordinary crystalloids, whereas more concentrated ones are colloidal electrolytes, and that excess of soap above saturation value separates out in the form of true crystals in the case of potassium soap and of white curd fibers in the case of sodium soaps. The transparent jellies are confined to a portion of the region in which the soap is a colloidal electrolyte. The most concentrated solutions, or those to which much salt has been added, are those which constitute anisotropic liquids.

Sols and the Theory of Colloidal Electrolytes

In the first place, it has been shown that hydrolysis is of negligible significance for the present purpose. Indeed, the hydrogen soap cetyl sulphonic acid, in which hydrolysis is impossible, behaves in most respects exactly like potassium stearate. Hydroxyl ion is a very minor constituent of ordinary soap solutions, being present only to the extent of about N/1,000. This has been shown by measurements of:

(a) Electromotive force, hydrogen electrode.
(b) Catalysis, nitrosotriacetonamine.
(c) Conductivity of solutions in contact with insoluble acid soaps.
(d) Analysis of the ultrafiltrate of concentrated soap solutions where nearly all the soap is held back as colloid.

We conclude, therefore, with some confidence that the major properties of soap solutions are due to the soap itself, and not to products of hydrolysis. There are, then, two properties of soap solutions of great significance—namely, osmotic activity and conductivity.

The osmotic activity was unexpectedly difficult to measure, and the well-known work of Krafft and Smits was found to be invalid. However, a wide range of concentrations of many soap solutions has been studied by the following four methods:

(a) Lowering of freezing point.
(b) Lowering of dew point.
(c) Minimum pressure for ultrafiltration through a dense membrane.
(d) Lowering of vapor pressure.

The result is that a strong solution of a higher soap may be said to exhibit one-half the esmotic activity of an ordinary salt. Of course, this is much increased in dilute solution and tends to diminish with rise of temperature, and the various soap solutions exhibit every intermediate value in the most regular fashion.

The conductivity is equal to that of a salt. This is attested by hundreds of measurements in which the most careful search has been made for sources of chemical and physical error, and results which have been repeated in other laboratories have confirmed our own.

There seems to be no alternative to the conclusion that half the conductivity of a soap solution is due to a negative carrier which does not exhibit osmotic activity and is therefore colloidal; that is, the ionic micelle. A colloidal electrolyte is a salt in which one of the ions is replaced by ionic micelle; that is, highly charged and solvated colloidal particles. The undissociated colloidal electrolyte consists of neutral micelle.

This interpretation leads to perfectly definite values for the concentration of each of the constituents of the solution, such as sodium ion and ionic micelle, and the mobility and equivalent conductivity of the latter directly follows. These values have been confirmed by the following methods:

(a) Measurement of sodium and potassium ions by sodium and potassium electrodes.
(b) Ultrafiltration through membranes which hold back all the colloid and permit all the crystalloids to pass.
(c) Measurements of electrolytic migration.

This view of the constitution of soap solutions is also in harmony with a mass of qualitative information.

Nearly all the ordinary soaps have been studied under a variety of conditions, and it is found that there is but little difference in the amount of neutral micelle in corresponding sodium and potassium salts. On the other hand, in potassium soap solutions the proportion of ionic micelle is always about 5/4 greater than in the sodium soap, and, moreover, the ionic micelle in potassium soaps persists to a dilution about twice as great as in the solutions of sodium soaps. From this it is concluded that the ionic micelle must contain a certain amount of neutral colloid, although, on the other hand, there is evidence that much of the latter exists independently as neutral micelle. The chief difference between potassium and sodium soaps, and also between the saturated and unsaturated homologous series, is not primarily due to difference in the consti-

tution of their solutions, but rather to the great difference in solubility, the highest saturated sodium soaps being practically insoluble at room temperature, although all are extremely soluble at the boiling point. Dilute solutions are crystalloidal apart from the colloidal acid soaps arising from hydrolysis which is prominent only in extreme dilution. Formation of colloidal electrolyte is favored by lowering of temperature, increase in molecular weight in the homologous series, and addition of salts.

Theoretical Consequences

1. It is thus established that true, complete, reversible equilibrium can subsist in a colloidal system between all the various crystalloidal and colloidal constituents.

2. There is here a clear proof that the colloidal particles are definite stable aggregates in true equilibrium with their crystalloidal components. The unit is the colloidal aggregate, not the molecule or simple ion, and the aggregate is large enough to be held back by an ultrafilter which allows the molecule to pass through. This throws decidedly unfavorable light upon the recent tendency to assume that the colloidal particles in the closely parallel protein and gelatin systems are merely large molecules which are otherwise in true solution. In the case of soap each particle of ionic micelle probably contains about ten ions which have retained their respective electrical charges.

3. There is every evidence that colloidal electrolytes constitute an enormous class of substances, probably as numerous as acids and bases put together, occurring both in aqueous and non-aqueous solutions. Indeed, they would appear to be particularly important in non-aqueous solutions, although this probability has so far been entirely neglected in the published literature. The characteristics of this class are essentially the occurrence of poly-molecular aggregates and ionic micelle.

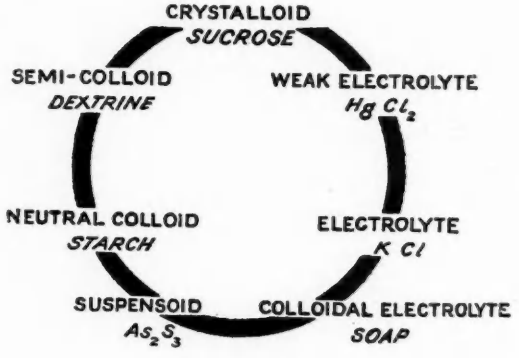
4. Colloidal particles may conduct better than true ions. This was our initial suggestion for harmonizing the data for protein systems. But it is necessary to be clear that it is not mere electrophoresis that is meant. The actual conductivity of one ionic micelle containing, say, ten palmitate ions is twenty or thirty times greater than that of a single palmitate ion; so that the equivalent conductivity of the ionic micelle is still several times that of the simple fatty ion. This is explained by an application of the principle underlying Stoke's law.

5. Consideration of the relationship between a particle of ionic micelle, which is revealed by its high conductivity and the corresponding sodium or potassium ions, leads to a modified picture of the electrical double layer and the phenomena connected therewith. It is obvious that the electrical conductivity of these ions and charged surfaces is not impaired by their participation in an electrical double layer.

6. The study of various organic derivatives, such as sulphonates, shows the importance of long molecules in the formation of colloidal electrolytes and jellies, as well as crystalline liquids.

7. The discovery of the ionic micelle, the extreme type of a fully charged colloidal particle, brings out clearly the transition through the slightly charged suspensoids to the other extreme of neutral colloids, such as rubber in benzene or nitro cellulose in non-ionizing solvents. It is clear that the existence and stability of such neutral colloids is almost or quite independent of electrical charges, and that solvation or sorption of solvent is the key to their behavior.

8. The following appears to be a rational classification of all solutions, showing the gradual transition between each pair of neighboring types:



9. It has been shown that soap in colloidal solution is hydrated, and the method used is of general applicability in colloid chemistry. It consists in the ultrafiltration of a sol to which an indifferent reference substance has been added. The filtrate is more concentrated as regard reference substance than the original sol, and from this the amount of solver held back in combination with the colloid is readily calculated.

The Existence and Properties of Soap Jellies

The salient facts observed by Miss Laing are the following: The conductivity of a soap solution is quantitatively unaffected when it sets to a clear, transparent, elastic gel. The same is true of its osmotic activity, as measured by lowering of vapor pressure and of the concentration of sodium ions measured by sodium electrode. Indeed, the only difference between sol and gel appears to be the mechanical rigidity and elasticity of the latter. Neither shows any structure in the ultramicroscope. During electrolysis the relative movement of the constituents of the solution is independent of whether it is a clear, elastic jelly or a fluid sol.

The Structure of Jellies

1. The identity of the significant properties of sol and gel proves that the same equilibria exist in each. The colloidal particles in sol and gel must be identical in kind and amount.

2. The unchanged conductivity shows that the process of electrical conduction is unchanged in kind and degree.

3. The "electrolytic migration" in soap solutions consists of identical processes with "electro-osmosis" of water through a transparent soap jelly and with the "electrophoresis" of pieces of soap jelly suspended in a soap solution. In each case the relative movement of, for instance, sodium and water is the same.

4. The identity of conductivity of sol and gel is particularly significant in discussing the structure of gels. Any theory conflicting with this is evidently untenable, as, for instance, Wo. Oswald's and M. H. Fischer's suggestion that gelatinization is due to reversal of phases; similarly with a closed honey-combed structure or even an only partly open structure. Some miscellar theory of gels is clearly indicated. In the case of soaps the structure is probably filamentous.

5. Thus, although soaps, proteins, etc., are commonly called emulsoid colloids, they cannot be regarded as emulsions.

6. Once more there is strong evidence that the colloidal unit is an aggregate of molecules, and that these colloidal units persist and retain their identity in larger structures, such as gels and coagula. This behavior appears to be general; compare, for instance, the study of particulate clouds (aerosols).

7. The apparent viscosity of such systems as soap and gelatin solutions has no marked effect upon electrical conductivity; the viscosity of a soap sol may be altered a thousandfold or it may be solidified to a clear, elastic jelly without affecting the molar conductivity.

The Properties of Soap Curds

These white opaque systems form a complete contrast to soap jellies. Under the ultramicroscope it can be seen that formation of a soap curd is due to the separation from solution of microscopic or ultramicroscopic fibers which may be of very great length and which have been shown to consist of neutral hydrated sodium soaps. Hydrated sodium soaps in their solid stable form consist of these curd fibers; whereas, hydrated potassium soaps form true lamellar crystals, the fibrous form being evanescent and unstable. The curd fibers possess a very high temperature coefficient of solubility, so that a commercial soap usually consists of such fibers enmeshing a soap sol or gel of the more soluble soaps. Formation of curd from a solution progressively lowers the conductivity to a value corresponding to the solubility at that particular temperature. The osmotic activity is similarly diminished, and the results are confirmed by the analysis of the expressed liquid.

The chief theoretical result is that there is a sharp distinction between true soap jellies and the soap curds with which they have been commonly confused. Gelatinization is not a process of crystallization in the sense of removal of colloidal particles from the sphere of action of the solvent; whereas, the formation of curd or coagulum involves this separation. Presumably, jellies in general should be distinguished from coagula.

The Concentration of Soap in the Surface

One result from our study of the surface concentration of soap and other solutions should not be passed over without mention. The surface tension of water is lowered to the extent of about 60 per cent in a very dilute solution (about N/1,000); and on further addition of soap the surface tension is not further diminished but rather increases very slightly.

According to the so-called Gibbs' adsorption equation,

$$\Gamma = \frac{-c}{RT}\,\frac{d\sigma}{dc}$$

there should therefore be a deficiency of soap in the surface of solutions of ordinary concentration. Actually, however, there is an accumulation in the surface which we have shown is not due to chemical decomposition. It seems to be the actual lowering of surface tension, and not the slope of the surface tension curve, which governs the occurrence of adsorption. A modified formula based on the actual lowering of surface tension would appear to be more nearly in accord with all the known facts.

In conclusion, it is seen that only a few aspects of this vast subject have been adequately investigated; but it appears that its exact elucidation, so necessary to place the soap industry on a scientific basis, will also have a bearing upon a surprisingly large number of theoretical considerations.

BIBLIOGRAPHY

[1] Zur Kenntnis der Konstitution von Seifenlosungen, Losungen von "Natriumpalmitaten."—James W. McBain and Millicent Taylor. (Z. fur physik. Chemie. **76,** 2, 1911, 179-209.)

[2] Uber die elektrische Leitfahigkeit von Seifenlosungen.—James W. McBain and Millicent Taylor. (Berichte, **43,** 2, 1909, 321.)

[3] Dichtigkeitsmessungen der Seifenlosungen.—E. C. V. Cornish. (Z. F. physik. Chemie., **76,** 2, 1911.)

[4] Studies of the Constitution of Soap in Solution: the Electrical Conductivity of Sodium Stearate Solutions.—R. C. Bowden. (Trans. Chem. Soc., 1911, **99,** 191-195.)

[5] Studies of the Constitution of Soap in Solution: Sodium Myristate and Sodium Laurate.—James W. McBain, E. C. V. Cornish and R. C. Bowden. (Trans. Chem. Soc., 1912, **101,** 2042-2056.)

[6] Studies of the Constitution of Soap Solutions: The Electrical Conductivity of Potassium Salts of Fatty Acids.—H. M.

Bunbury and H. E. Martin. (Trans. Chem. Soc., 1914, **105,** 417-435.)

[7] Studies in the Constitution of Soap Solutions: The Alkalinity and Degree of Hydrolysis of Soap Solutions.—J. W. McBain and H. E. Martin. (Trans. Chem. Soc., 1914, **105,** 957-977.)

[8] The State of Potassium Oleate, and of Oleic Acid in Solution in Dry Alcohol.—M. E. Laing. (Trans. Chem. Soc., 1918, **113,** 435-444.)

[9] The Hydrolysis of Soap Solutions, measured by the Rate of Catalysis of Nitrosotriacetonamine.—James W. McBain and T. R. Bolam. (Trans. Chem. Soc., 1918, **113,** 825-832.)

[10] The Hydrolytic Alkalinity of Pure Commercial Soaps.—F. C. Beedle and T. R. Bolam. (J. Soc. Chem. Ind., 1921, **40,** No. 4, 27t-29t.)

[11] Colloidal Electrolytes: Soap Solutions as a Type.—James W. McBain. (J. Soc. Chem. Ind., 1918, **37,** 249t-252t.)

[12] Colloidal Electrolytes: Soap Solution as a Type.—James W. McBain, M. E. Laing and A. F. Titley. (Trans. Chem. Soc., 1919, **115,** 1279-1300.)

[13] Colloidal Electrolytes: Soap Solutions and Their Constitution.—James W. McBain and C. S. Salmon. (J. Amer. Chem. Soc., **42,** No. 3, 1920, 426-460.)

[14] Colloidal Electrolytes: Soap Solutions and Their Constitution.—James W. McBain and C. S. Salmon. (Proc. Roy. Soc., A, **97,** 1920, 44-62.)

[15] Colloids and Colloidal Electrolytes.—James W. McBain. (Nature, March 10, 1921, 46.)

[16] A Novel Magneto Effect.—James W. McBain. (Nature, March 17, 1921, 74.)

[17] The Investigation of Sodium Oleate Solutions in the Three Physical States of Curd, Gel and Sol.—M. E. Laing and James W. McBain. (Trans. Chem. Soc., 1920, **117,** 1506-1528.)

[18] The Degree of Hydration of the Particles Which Form the Structural Basis of Soap Curd, Determined in Experiments on Sorption and Salting Out.—James W. McBain and Millicent Taylor. (Trans. Chem. Soc., 1919, **115,** 1300-1308.)

[19] The Hydration of the Fibers of Soap Curd: Part I. The Degree of Hydration Determined in Experiments on Sorption and Salting Out.—James W. McBain and H. E. Martin. (Trans. Chem. Soc., 1921, **119,** 1369-1374.)

[20] The Hydration of the Fibers of Soap Curd: Part II. The Dew-Point Method.—James W. McBain and C. S. Salmon. (Trans. Chem. Soc., 1921, **119,** 1374-1383.)

[21] The Hydration of the Fibers of Soap Curd: Part III. Sorption of Sodium Palmitate.—M. E. Laing. (Trans. Chem. Soc., 1921, **119,** 1669-1676.)

[22] The Effect of High Concentration of Salt upon the Viscosity of a Soap Solution.—A. M. King. (J. Soc. Chem. Ind., 1922, **41,** No. 9, 147t-148t.)

[23] Studies of the Constitution of Soap Solutions: Solutions of Sodium Palmitate, and the Effect of Excess of Palmitic Acid or Sodium Hydroxide.—James W. McBain, M. Taylor and M. E. Laing. (Trans. Chem. Soc., 1922, **121,** 621-633.)

[24] Direct Experimental Determination of the Concentration of Potassium and Sodium Ions in Soap Solutions and Gels.—C. A. Salmon. (Trans. Chem. Soc., 1920, **117,** 530-542.)

[25] Note on the Effect of Electrolytes on the Constitution of Soap Solutions, as Deduced from Electromotive Force.—C. S. Salmon. (Trans. Chem. Soc., 1922, **121,** 711-715.)

[26] The Ultramicroscopic Structure of Soaps.—W. F. Darke, J. W. McBain and C. S. Salmon. (Proc. Roy. Soc., A, **98,** 1921, 395-408.)

[27] Colloid Chemistry of Soap: Part I. Solutions.—J. W. McBain. Third Report on Colloid Chemistry, British Association for the Advancement of Science, 1920, pp. 1-31. Reprinted in serial form in the Oil and Trade Colour Journal, 1921, and the Seifensieder Zeitung, 1921.

[28] The Colloid Chemistry of Soap. Part II. The Soap Boiling Processes.—J. W. McBain and E. Walls. (Fourth Report on Colloid Chemistry, British Association for the Advancement of Science, 1922, pp. 244-263.)

[29] Studies of the Constitution of Soap Solutions: Sodium Behenate and Sodium Nonoate.—O. J. Flecker and M. Taylor. (Trans. Chem. Soc., 1922, **121,** 1101-1109.)

[30] The Effect of an Electrolyte on Solutions of Pure Soap. Phase Rule Equilibria in the System-Sodium, Laurate-Sodium Chloride-Water.—J. W. McBain and A. J. Burnett. (Trans. Chem. Soc., 1922, **121,** 1320-1333.)

[31] A Study of the Rate of Saponification of Oils and Fats by Aqueous Alkali, Under Various Conditions.—M. H. Norris and J. W. McBain. (Trans. Chem. Soc., 1922, **121,** 1362-1375.)

[32] The Ultrafiltration of Soap Solutions. Sodium Oleate and Potassium Laurate.—J. W. McBain and W. J. Jenkins. (Trans. Chem. Soc., 1922, **121,** 2325-2344.)

[33] The Constitution of Soap Solutions: Hexadecanesulphonic (Cetylsulphonic) Acid, and Other Sulphonates.—M. H. Norris. (Trans. Chem. Soc., 1922, **121,** 2161-2168.)

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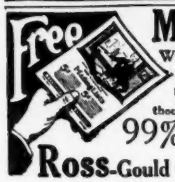

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